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ELECTRICITY FOR NOTHING.

WE observe that our old friend the Lalande-Chaperon battery, which has been improved (?) by others, is once more to the fore. The construction and special features of this element have been exhaustively treated in the REVIEW, and it will be remembered that its electromotive force is very very low. A point urged in its favour, however, was the supposition that its bye-products would realise considerable sums, in fact, more than the cost of producing electrical energy; in other words, the company working this invention would be able to charge consumers for electric lighting which would cost them, as suppliers, nothing. Profs. Jamieson and Tait, Dr. Squire, and Mr. Stanley C. Currie, have reported upon the battery, and, to the casual observer, everything appertaining thereto bears a roseate hue. If we look more closely into these reports, however, we discover that things are not what they seem.

It appears that the Lalande-Chaperon battery is intended to be used for a similar purpose to that for which the gas generator of Mr. Upward, which has recently been described by us, is designed, viz., to charge secondary cells, and not for direct lighting. An installation has been put down in some city offices, and gas has, we understand, been dispensed with. So far so good. But the question is, at what cost?

There appears to be a diversity of opinion as to the local action which goes on in the Lalande-Chaperon cells. Dr. Squire, whoever that gentleman may be, says: "Unless the circuit is completed, nothing happens." Mr. W. Peddie, on the contrary, who reports on behalf of Prof. Tait, makes the following remark: "*Local Action.*—The average weight of each zinc plate was 23 lbs. 7 oz., when the battery was first set up. To test the cells for local action, which seemed to be considerable, they were left on open circuit for a fortnight. In that time the average loss of weight of each plate was 2 lbs. This action continued during the whole time of testing the battery."

The consumption of zinc to produce one horse-power hour is, according to the reports, a little over 4 lbs., but when used in connection with secondary batteries the amount of zinc consumed rises to 7½ lbs. It is stated by Mr. Stanley C. Currie that the zinc hitherto used has been the ordinary commercial article, but that arrangements are being made for obtaining a specially rolled metal of greater purity. We doubt whether this could be purchased for less than threepence per lb., and, at this rate, the cost of zinc alone per horse-power hour, amounts to nearly two shillings. Some 9 per cent. of this cost is, according to Mr. Peddie, accounted for by local action, but we think this percentage is really much below the true figure, for the actual consumption of zinc per horse-power hour appears to be greatly in excess of the necessary theoretical quantity. The working cost then seems to be considerably higher than that of the Upward system, which we still look upon as the greatest advance which has yet been made in primary battery development.

Respecting the value of the bye-products which result from the exhaustion of the Lalande-Chaperon elements, we have yet to learn that they possess any. For several years past, and at periodic intervals, the "Electricity for Nothing" scheme has been enticingly placed before the public, but we are unaware of any business having yet been transacted upon such a basis.

So far as we can learn, the secondary batteries must be charged in parallel with, say, two cells in series. The discharge, we presume, takes place when the cells have all been switched in series. For an operation of this kind, *a la* Planté, a special commutator becomes necessary, and complications may arise. The data published by the gentlemen we have named are insufficient in almost all respects, and we cannot see that the cause of electric lighting is in any way advanced by the advocacy of the Lalande-Chaperon invention. *If*, as Professor Jamieson remarks, it can be satisfactorily proved upon a commercial scale that a ready market can be found for the sulphide of zinc—the bye-product which is to be employed in manufacturing zinc white paint—at a small profit to cover the expenses of refitting the batteries, then, undoubtedly, "you get your electricity for nothing." It is just the fact that the residue of worked-out batteries has hitherto been comparatively worthless which makes electric lighting by primary batteries so expensive, and it has yet to be proved that the galvanic elements we have commented upon stand any better chance of succeeding than others which have come and have gone again. Even if these residual products possessed the value claimed for them and the market were found ready to hand, we should then anticipate that the difficulty and expense attached to the collection of comparatively small quantities of liquids and the refilling of the cells at places perhaps very far apart, would constitute, if not a source of loss, certainly not one of profit.

Cocoa-Nut Palms and Lightning.—In a recent article the *Ceylon Observer* refers to the power of the cocoa-nut palm to conduct lightning. Sir Emerson Tennent long ago pointed out that this tree acts as a conductor in protecting houses from lightning, and in one instance 500 palms were struck in a single plantation during a succession of thunderstorms in April, 1859. But the trees themselves suffer terribly in the process, for however slightly they may be touched by the electric fluid, they die. Sometimes only the edges of the branches are singed, at others a few leaves turned brown alone show where the tree was touched, yet however slight the apparent effect, in course of time the tree withers gradually and dies. In conclusion the journal quoted inquires why it is that cocoa-nut palms which have merely had their external parts, their foliage, almost imperceptibly singed should be as much doomed to death as those which have had their vital parts permeated by the lightning, the fatal result being only protracted in the one case, while it is instantaneous in the other.

THE EFFECT OF LIGHTNING ON HUMAN BEINGS.

THE effect which a stroke of lightning exercises on human beings has, no doubt, been often seen and described, but there is nevertheless much about it that is obscure. At the last meeting of German scientists at Hamburg Dr. Heufner described certain cases which had come under his immediate notice, whereby some exceedingly remarkable physical effects of being struck by lightning were demonstrated. The principal contents of his report were as follows :—

Sunday, July 13th, 1885, a horse race was to take place at Barmen to which a number of spectators flocked in spite of an approaching thunderstorm. The course was enclosed with canvas stretched between poles in the ground, and, as this wall afforded shelter against the wind and rain, which soon began to play, the spectators crowded against it. Suddenly a stroke of lightning descended, split two poles, tore away a large portion of the canvas, and felled twenty persons to the ground. Four of these were killed on the spot, and sixteen recovered consciousness in the space of a few minutes to an hour. The greater number of the sufferers were treated by Dr. Heufner, and from the others he received detailed statements. According to those who had at once rushed to the assistance of the persons struck, their faces bore an ashen colour, their countenances were distorted, and the extremities cold as ice.

One lady, severely struck, felt, on regaining consciousness, an intense giddiness, "as if a wheel spun round in her head." She remained almost insensible till the following day, complaining greatly of weakness and pains in the limbs. Her legs were for several hours pale and cold and insensible to touch, but in the sole of the foot she felt stinging pains. Behind the left ear, as far as the shoulder, ran a broad irregular burn or scorch, in the centre of which the skin had become hard as leather. Smaller burns and red spots were found on the right breast and the right arm. By the sole of the foot on both sides there were circular greyish-white spots with perforated centres, surrounded by lacerated and fatty scorched masses of the epidermis. These spots were situated at the edge of the toes, and showed little reaction during the first few days, whereas the burns on the upper parts of the body began to swell on the following day. In shape they reminded one of the hole which an electric spark makes in a piece of cardboard. By the sole of the foot of one man there were no less than twenty-four apertures of various kinds, and a corresponding number was found on the boot of the sufferer. All the holes were also in this case situated in the lower edge of the upper boot, only very fine ones being found in the actual sole. Hardly bigger were the holes Dr. Heufner found in the boots of another of the sufferers he examined, and he says "it seems remarkable that lightning possessing the power of striking a man dead on the spot, should be able to find an outlet through such tiny openings." With persons who wore shoes studded with metal knobs there were no holes in the soles, as the former had doubtless acted as conductors. The damage made to the clothes of the sufferers was, on the whole, very small, but in the spots where the body bore burns, the coat and waistcoat showed small round holes half a centimetre in diameter. In the lining and the underclothing the holes increased in size, those in the shirt being as big as a shilling. In the hat of a boy there were three holes through the felt, about the size of a quill, whilst those in the lining were much larger. The hat with its many perforations demonstrated that the lightning had not descended in a single stroke, but in several.

The great increase in the destruction of the lining and inner garments is doubtless due to the circumstance that the electric current encounters a considerable degree of resistance through the non-conducting qualities of the epidermis, which causes it to develop its greatest energy in this locality. It is also the resistance of the epidermis which causes the sudden and violent rupture of the skin, resulting in great injury to the same. Except those who were lightly struck having only solitary burns or red spots, all the others had on the upper part of the body several burns of various sizes and irregular shape, whence red streaks radiated more or less over the body and limbs, and which after a while became covered with a crust. In some cases the hair on the skin was singed in a streaky manner, clearly proving that the lightning had passed across the skin ; in others the streaks formed tooth shaped and bifurcated figures, such as are drawn in text books of physics for illustrating the so-called lightning figures.

Quite different was the injury done to the feet, and, may be, this difference between the wounds of the upper and lower parts of the body is due to a polar variation of the electric current. It is, we know, a fact, that the positive pole affects the human body differently to the negative.

When the current reaches the moist part in the interior of the body it may without difficulty and without doing much damage strike in all directions ; this applies chiefly to the brain, the spine, and the eye, which are some of the best conductive parts of the body. It is for this reason that a stroke of lightning hitting the head is not always mortal, and that the exterior apparent injury shows a strong contrast to the intact state of the skull and brain. This was, for instance, the case with a boy fourteen years of age, who, in the middle of the forehead, just under the hair, had a burn about the size of a shilling. Four days after the catastrophe the boy—whose skin on the forehead and upper eyebrows was very red and swollen, and whose eye-lashes were singed—presented a frightful spectacle. He showed every sign of a great shock to the brain, the closing scenes of the race having entirely disappeared from his recollection, whilst he also during the same period suffered greatly from vomiting, and was for several weeks in a very low state, *but he suffered no permanent injury to the brain whatever from the stroke.*

Besides the injury to the head, this boy had for several months a burn on the upper rib, whence an incrusted scar ran behind, and, parting into two streaks above the loins, continued down the back of both legs to the heel. His terribly injured feet were at first very cold, remaining benumbed for hours at a time, then they became very swollen, phenomena which were also observed in the other sufferers, and which may perhaps be connected with cramp experienced at first and the subsequent paralysis of the muscular system.

It is generally stated as an important fact that persons struck by lightning have no recollection of the occurrence. Lightning, with its enormous velocity, paralyses and kills before its light can reach the ocular, or its sound the oral, nerves, and the victim thus become conscious.

The lady referred to above would not believe, when told so in the hospital, that she had been struck by lightning ; and a man who on recovering, hearing her cries for help, attempted to rush to her assistance, found to his great surprise that he could not move a muscle. This again seems to explain the strange circumstance that those who have been struck by lightning, as a rule, show no fear or excitement, but rather apathy.

Several of those struck in this case had, however, some recollection of being hit, having, doubtless, first suffered unconsciousness a moment later. One of them related that he had felt being struck and sinking down with a sensation as of being torn to pieces. Another stated that he felt a blow in the neck as from a thick stick, and he became always afterwards very frightened during a thunderstorm. A third, who still recollected seeing a man falling ashy pale by his side, compared the shock he felt when struck, to the blow of a sledge hammer on an anvil without its rebound.

THE PORTE-MANVILLE ELECTRIC GOVERNOR.

ELECTRICAL governors are generally intended to keep either the electromotive force or current of a dynamo constant. They have great advantages over any mechanical governor, for by their means the required object may be attained by directly controlling the engine throttle valve or expansion gear, and so altering the speed of the engine; or, if it is necessary to run the engine at a constant speed, by reason of its driving other machinery, the electrical governor will introduce or withdraw resistances in the field magnet circuit. The chief advantage of the former method over the latter is the reduction of wear and tear, for the speed never exceeds the minimum that is necessary to do the required work. Neither plan can be effected with any mechanical governor alone, but the electrical governor can be used in conjunction with a mechanical governor to alter the length of the connecting rod between the mechanical governor and valve, so permitting the mechanical governor to alter the speed of the engine to the new speed required.

The Porte-Manville electric governor consists of a standard carrying a spindle, on which are fixed two ratchet wheels, whose teeth are cut in opposite directions. This spindle is made to give either a direct rotary motion, such as is required to close turbine

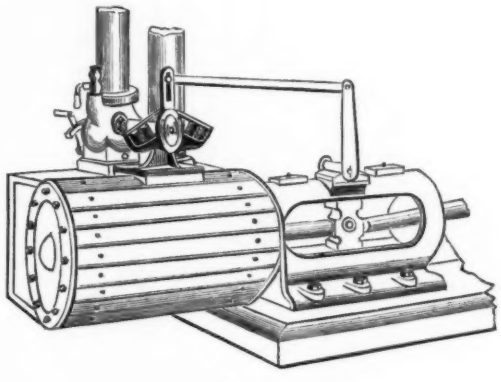


FIG. 1.

gates, or by means of a screw and nut, a simple to and fro motion, such as is required to operate the throttle valve or expansion gear of a steam engine. A frame rocking about this spindle as a centre, and operated by an eccentric or other suitable means, carries two pawls,

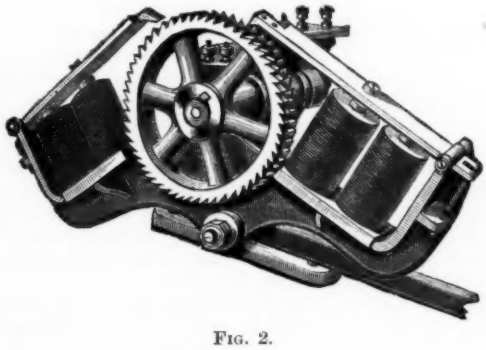


FIG. 2.

which drop one into each ratchet wheel. These pawls are normally held off by springs, and are caused to engage with the ratchets by the operation of electro-magnets, to which they form armatures. An E.M.F. or current regulator is arranged in the circuit to be governed so that when the electromotive force or current exceeds or falls below a certain limit it closes one or other of the electro-magnet circuits; the corresponding pawl engages and adjusts the valves, or varies the field magnet resistance. This regulator is extremely sensitive, responding readily to a variation of one per cent., and the governor is remarkably free from any tendency to "hunt." It has the great advantage over other electrical governors that the power required to move the valve is supplied by the motor itself, the current simply directing the action of the governor, so that when the E.M.F. or current regulator is once adjusted, the governor requires no attendance at all; another advantage is, that it has absolutely no delicate parts about it.

Fig. 1 shows the horizontal form of governor attached to a steam engine with a horizontal throttle valve.

Fig. 2 shows the horizontal form, ready for attachment to a turbine, &c.

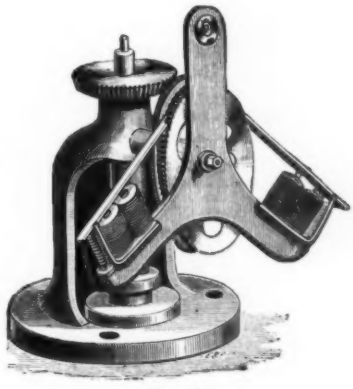


FIG. 3.

Fig. 3 shows the vertical governor by itself ready for attachment to an engine with a vertical valve.

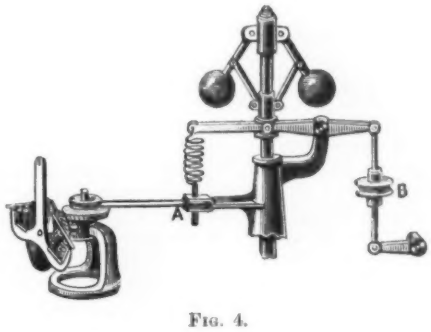


FIG. 4.

Fig. 4 shows the governor in combination with a mechanical governor which it controls by altering the length of connecting rod at B, or by varying the tension of the governor spring at A.

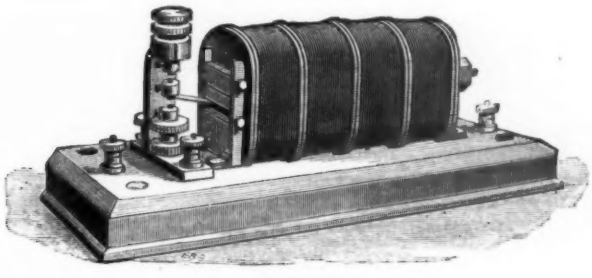


FIG. 5.

Fig. 5 shows the repulsion regulator, either shunt wound for incandescent machines, or series wound for arc machines; it is required in combination with either form of governor.

Instructions for fixing the Porte-Manville Governor and Repulsion Regulator.

The governor is to be mounted in a convenient position near the valve or valve gear. When the motion required for regulating the valve gear is longitudinal, the travelling nut on the screw of the governor is to be connected to the valve gear by suitable connecting rods, two pins being left on the nut for the purpose.

If the required motion is rotary, the screw spindle should be coupled to the valve gear. The rocking frame on the governor is to be worked by a connecting rod from some convenient crank, or other moving part on the motor; the amount and rate of oscillation depending on the nature of the motor and valve gear. This can be easily determined by trial, or the makers of the apparatus will advise for each special case.

The regulator should be placed in a very clean place, and preferably in the dynamo room.

The connections of the apparatus are shown by the attached diagram.

The two terminals marked A and B on the regulator are to be respectively connected to the positive and negative dynamo brushes, or at a convenient position on the main cables.

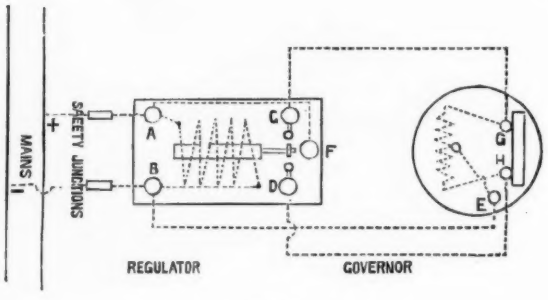


FIG. 6.

A is also to be joined to the middle terminal, marked F, at the other end of the regulator, and B to the terminal, E, on the standard of the governor. The terminals, C and D, in connection with the bottom and top contact stops respectively of the regulator are to be connected to the terminals, G and H, in the governor.

It must be ascertained by trial that this arrangement actuates the valve gear of the motor in such a way that the motor is caused to quicken its speed when the E.M.F. in the circuit to be controlled is too low, and to slacken its speed when the E.M.F. is too high. If the arrangement of the valve mechanism is such that the opposite effect takes place, the connections between C, D and G, H, must be reversed, C being connected to H, and D to G.

The screw stops in the travelling nut on the governor are for breaking the circuit of the electro-magnets, and preventing accidents when the valve gear has been moved to the full extent of its proper travel in either direction; these stops can be adjusted for different extents of travel.

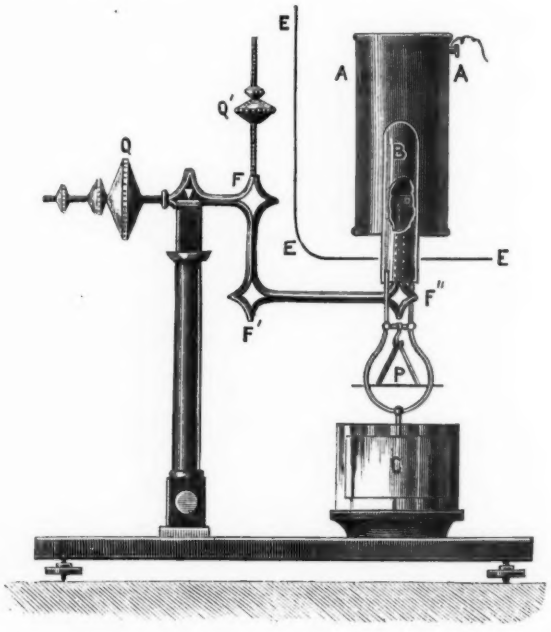
All the connections should be made with thoroughly well insulated wire, and it is advisable to put a small safety fuse in each of the connections to the main leads as shown in diagram.

AN ABSOLUTE ELECTROMETER FOR HIGH POTENTIALS.

By Messrs. BICHAT and R. BLONDLOT.

THE absolute electrometer that we described in a previous issue enables us to measure potentials accurately up to 56 C.G.S. electrostatic units, corresponding to a sparking distance of about 5 millimetres. If this limit is exceeded, disturbances arise in the working of the apparatus arising from the fact that the movable cylinder, being suspended at the extremity of a long rod, undergoes lateral attractions, in consequence of which the axes of the two cylinders no longer possess the parallelism required according to the theory of the instrument. In the new apparatus the movable cylinder, B, is supported near the centre. For this purpose it has in its interior a knife edge with a rounded indentation resting on another knife edge similarly indented placed at right angles to the first, and fixed at the extremity of the beam of the balance. This beam is bent at the points, F, F′, F″, so that the edges of the suspending knives of the movable cylinder and of the beam are on the same horizontal plane.

Two counterpoises, Q and Q′, enable the beam to be kept in equilibrium and the height of its centre of gravity to be modified. From the bottom of the cylinder, B, two rods hang, between which the beam passes, and these are then united to support a cylinder, C, formed of paper stretched upon a metallic frame. The cylinder, C, tends to check the oscillations of the balance; for this purpose it is enclosed in a cylindrical vessel somewhat larger in diameter, furnished with a lid having a hole in the centre to allow the suspending rod to pass through.



A tray, P, is suspended to the cylinder, B, for the purpose of holding weights used to measure the attraction exercised by the cylinder, A, upon the cylinder, B.

A bent screen, E, E, E, with an opening, allows the movable cylinder to pass through.

The advantages of this new apparatus are as follows: the point of suspension of the movable cylinder being placed at the centre, the result is that not only are the lateral attractions very slight, but they partly counteract one another, the disturbance mentioned above being almost annulled. Besides, the cylinder, C, being placed very low, and having considerable weight, tends to keep the movable cylinder vertical.

Thus absolute stability is obtained, and the measurements may be extended to potentials corresponding to sparking distances of 2·5 centimetres.

The formula which expresses the absolute value of the square of the potential in units of the weight, p'', necessary to equalise the attraction of the two cylinders is, as in the first model

$$V^2 = 4\,p\,g\,L\,\frac{R}{r},$$

R and r representing the radii of the two cylinders and g the coefficient of terrestrial acceleration.

A model of this instrument has been admirably constructed by M. D. Gaiffe, of Nancy, who has succeeded in combining lightness with great solidity.

We have applied it to the measurement of potentials corresponding to sparking distances varying between 1 millimetre and 22 millimetres, between two balls 1 centimetre in diameter. The results of these measurements are given in the following table. Against our own values we have given the corresponding ones obtained by M. Baille by means of a Thomson electrometer for sparking distances extending from 1 to 10 millimetres :—

Sparking distance.	Potentials in electrostatic units.	
	Bichat and Blondlot.	Baille.
0·1	16·1	15·25
0·2	27·5	26·82
0·3	38·2	37·32
0·4	47·7	47·62
0·5	56·3	54·66
0·6	64·9	65·23
0·7	71·6	72·28
0·8	77·0	77·61
0·9	81·6	80·13
1·0	84·7	83·05
1·1	88·7	,,
1·2	91·3	,,
1·3	93·8	,,
1·4	95·8	,,
1·5	97·8	,,
1·6	99·2	,,
1·7	100·8	,,
1·8	101·8	,,
1·9	103·2	,,
2·0	104·5	,,
2·1	105·4	,,
2·2	106·4	,,

The figures showing the results of M. Baille's experiments and of ours agree as closely as can be expected in experiments of this nature.—*Comptes Rendus.*

THE HEATING OF AERIAL CONDUCTORS BY ELECTRIC CURRENTS.*

By J. GILBERT WHITE, Ph.D.

INTRODUCTION.

WHILE engaged on some tests for the Franklin Institute at the Electrical Exhibition, in the fall of 1884, the writer found it necessary to consider the effect of heating and consequent change of resistance of aerial conductors carrying electric currents, and was unable to find any data by which the change of temperature due to the passage of a given current, under different conditions of exposure could be determined. It had been noted that, in some cases, covered wires were less heated than naked, by the same current, and Sir W. Thomson had shown by mathematical analysis that such should be the case for certain values of emissive and conducting powers. But to what extent these conditions obtained in practice, whether covered wires in general kept cooler than naked, or did so only in exceptional cases, had not been determined, and nothing, so far as the writer knew, was known of the relation that existed between the heating of covered and naked wires for any particular case.

It seemed, therefore, desirable that such experiments should be instituted, and in the winter of 1884–5, the writer proposed to Mr. J. G. White, then pursuing a course of graduate study at the Cornell University, to make a thorough study of the subject both theoretically and experimentally. The method adopted for the experimental investigation made it necessary to have continous wires partly covered and partly naked. These were obtained through the courtesy of the Electrical Supply Company of New York, who induced manufacturers to prepare for the purpose samples of wire in lengths of about 100 feet, half covered and half uncovered, of a great variety of styles of covering. The investigation proved a much more extended one than was anticipated, and Mr. White, having accepted a position in the University of Nebraska, was obliged to leave it before completing all that had been planned. It is believed, however, that the results so far obtained are of sufficient value to warrant their publication, and it is expected that the investigation will be continued.

WM. A. ANTHONY.

Physical Laboratory,
Cornell University,
Ithaca, N.Y., *May 10th*, 1886.

* New York *Electrical Engineer.*

The heating of conductors by electric currents is a subject of great practical as well as theoretical interest. It constitutes a leading factor in many of the electrical engineering problems of the day, especially in those of electric lighting and transmission of power. All electricians are familiar with the heating of wires by currents, and know that overheating is not economical, injures the insulation, and may even lead to firing of buildings or ordinary combustibles.

Yet very little has been written in this country on the subject; and, so far as we can learn, no experiments have been made. Letters from several of the leading electricians of the country show that quite diverse opinions are held on the most important and practical problems connected with the subject. Furthermore, many of the practical electrical engineers compute the size of wire to be used for any purpose by the rule (prescribed by the Board of Underwriters) of allowing a certain number of ampères current per square inch cross-section of the conductor. This rule, as we shall show later, is proven to be wrong by theory and by experiment, and might lead to serious consequences if the computations were for large currents.

In Europe a number of articles have appeared in the scientific periodicals which have discussed the various questions connected with electric conductors; but the results arrived at have been quite unlike, and very few have gone into any experimental verification of their theoretical deductions. It has, therefore, seemed wise to undertake some experiments which might verify the results of the theoretical solutions which might be found in other articles or which might be deduced. A description of the method of conducting the experiments and a synopsis of the results will now be given in order that these results may be referred to from the theoretical discussions given later in this paper; and the results reached by the two methods compared.

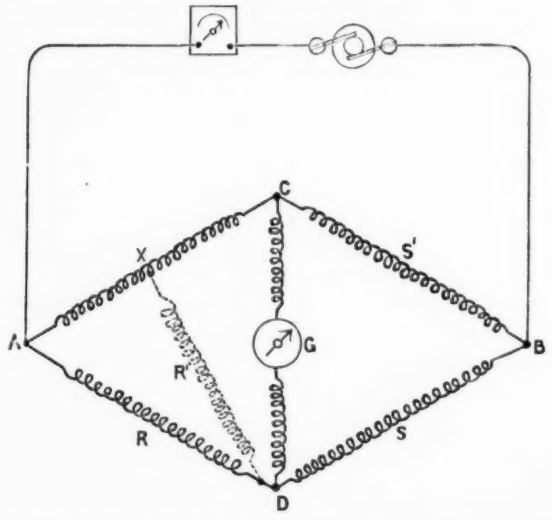
The currents used in the experiments were obtained from a Gramme generator, independently excited by a small Weston generator. By having a proper set of resistance coils in the "field" of the Weston machine and also between the Weston and the "field" of the Gramme machine, the amount of the current could be varied at will. The temperature of the wire experimented upon was determined by its resistance, which was measured by means of a Wheatstone bridge.

An idea of the connections may be obtained from an inspection of the following figure.

X consists of the wire under consideration. When two wires were to be compared they were joined and the current sent through them in series. By means of a temporarily devised mercury key the connections could be made so as to give R the position shown full or dotted. By determining R and R′ alternately, we get values for the resistance of one wire and of both. By subtracting the average value of R′ from the average value of R, the value of the resistance of the other wire could be obtained. R and R′ were readings on one of Elliott Brothers' four dial resistance boxes; and since they were always thousands of ohms, any slight difference in the resistance of the connecting wires in the two positions would be entirely inappreciable. S was a length of No. 00 insulated wire very loosely coiled so

as to be well ventilated. X was in most of the experiments a No. 16, No. 18, or No. 20 wire, and hence S being so much larger than X in diameter, would not be appreciably heated by the currents which were used to heat X.

At all events, all the experiments of practical significance consisted in the comparisons of two wires; and, since any slight alteration of S would make the same percentage of difference in R and R′, such a change would not vitiate the results. A little study of the experiments in the results of which this slight change in S would introduce *any* error, shows that, at most, this error would be only a fraction of one per cent. Owing to the variable factors which enter into these results, this is considered as within the limits of attainable accuracy for these particular experiments. S was a part of the resistance of an ordinary resistance box, and remained constant during any set of experiments; but was varied when a new wire was placed at



X so as to have R as large as possible in all instances. Connections were so made that by keys on the resistance box containing, R, the circuit, A, R, D, S, B, could be closed, and immediately afterward, the galvanometer circuit. As X and S were only fractions of an ohm, and as (R + S) was always thousands of ohms, the current which flowed through R and S for the short time during which the circuit, A, R, D, S, B, was closed, was very small; and R and S were not appreciably heated. G was a delicate galvanometer.

The above description shows that the bridge was so arranged that the results obtained from its readings can be relied on. In each of the experiments the resistance of the wire, X, was obtained, when the wire was cold, by means of one or two gravity cells. Then as only X and R changed during the experiment, the increase in R would enable the per cent. of increase in X to be computed. The temperature of X was then computed, on the assumption that the resistance of X increased 0·388 per cent. for each rise of one degree centigrade. This assumption is not exact, since $R' = R(1 + at + bt^2)$, in which equation R′ is the resistance at any temperature, t, R the resistance at zero, and a and b are constants determined experimentally. Now b is so small in comparison with a, that it is only when t becomes of considerable magnitude, that the second term becomes worthy of attention. The calculations have therefore been made as indicated above.

To determine the current flowing at any time one of Thomson's ammeters with sliding magnet and needle was connected in the main circuit. The constant of this instrument was determined by means of the copper voltameter, and found to be 5·2608, or with instrument set

at 32	current	=	·1644 ×	deflection
„ 16	„	=	·3288 ×	„
„ 8	„	=	·6576 ×	„
„ 4	„	=	1·3152 ×	„

Other determinations by other persons, during the progress of the experiments given below, gave almost exactly the same result. The experiments are given below not in the order in which they were made; but in what seems to be the logical sequence.

EXPERIMENTS, SET 1.

To determine the law of variation of the temperature of a conductor after starting through it a current of constant intensity. To determine this law the main circuit was so arranged that it could be closed by means of a mercury key at any instant. Several of the students in the laboratory kindly assisted in this experiment; so that the following arrangement could be made. One person observed and took frequent readings on the ammeter, to see that the current remained steady. Another closed the circuit at the beginning of a minute; at the expiration of each half minute thereafter he called out a signal, having given a warning signal five seconds before.

The writer was stationed at the "bridge," and maintained, by changing R, as nearly as possible a balance, calling out the reading of R to another person at the end of each half minute. Of course, the exact values of R at the precise instant could not be determined, owing to its constantly changing magnitude; but fairly accurate results were obtained as is shown by the smoothness of the curves on the cross-section paper. In laying out these curves, the rise in temperature of X in degrees calculated as explained above, was taken as an ordinate, the number of half minutes since the closing of the circuit being taken as the corresponding abscissæ. The results of the experiments are tabulated below, and the curves plotted on cross-section paper, plate I. Experiments 1, 2, 3, 4 were made with Clark insulated wire; 5 and 6 with bare wire of same size, 0·038 inch in diameter.

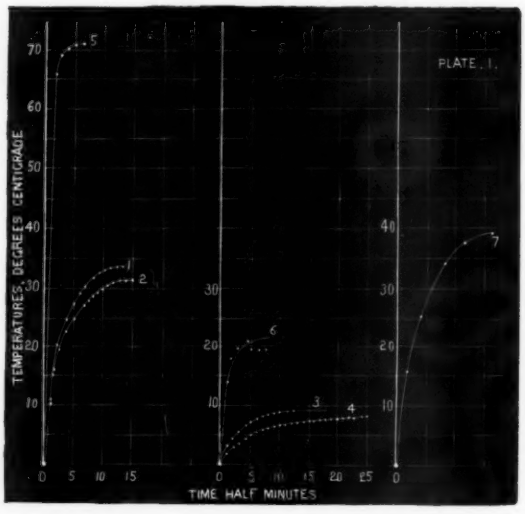


TABLE I.—EXPERIMENT 1.—SET 1.

Time in half minutes.	Values of R.	Increase in values of R.	Rise in temp. of X.
0	3735	...	...
1	3880	145	9·66
2	3960	225	15·00
3	4030	295	19·66
4	4070	335	22·33
5	4107	372	24·80
6	4135	400	26·26
7	4160	425	28·33
8	4173	438	29·20
9	4182	447	29·86
10	4190	455	30·33
11	4196	461	30·73
12	4200	465	31·00
13	4202	467	31·13
14	4203	468	31·20

TABLE II.—EXPERIMENT 2.—SET 1.

Time in half minutes.	Values of R.	Increase in values of R.	Rise in temp. of X.
0	3757	...	...
1	3910	153	10·20
2	3990	233	15·41
3	4060	303	20.20
4	4115	358	23·86
5	4155	398	26·13
6	4180	433	28·86
7	4205	458	30·06
8	4223	476	31·26
9	4240	493	32·86
10	4250	503	33·53
11	4255	508	33·86
12	4258	511	34·06
13	4258	511	34·06
14	4255	508	33·86

TABLE III.—EXPERIMENT 3.—SET 1.

Time in half minutes.	Values of R.	Increase in values of R.	Rise in temp. of X.
0	3746	...	0·0
1	3785	39	2·60
2	3810	64	4·26
3	3827	81	5·40
4	3842	96	6·40
5	3854	108	7·20
6	3862	118	7·86
7	3868	124	8·20
8	3872	128	8·46
9	3878	134	8·93
10	3880	136	9·06
11	3882	138	9·20
12	3883	139	9·26

TABLE IV.—EXPERIMENT 4.—SET 1.

Time in half minutes.	Values of R.	Increase in values of R.	Rise in temp. of X.
0	3735	...	...
1	3762	27	1·80
2	3782	47	3·13
3	3795	60	4·00
4	3806	71	4·70
5	3815	80	5·33
6	3821	86	5·73
7	3826	91	6·07
8	3832	97	6·44
9	3836	101	6·70
10	3839	104	6·93
11	3841	106	7·07
12	3843	108	7·20
13	3844	109	7·27
14	3845	110	7·33
15	3847	112	7·48
16	3848	113	7·54
17	3849	114	7·60
18	3851	116	7·73
19	3852	117	7·80
20	3853	118	7·86
21	3854	119	7·93
22	3855	120	8·00
23	3854	119	7·93
24	3853	118	7·86
25	3854	119	7·93

TABLE V.—EXPERIMENT 5.—SET 1.

Time in half minutes.	Values of R.	Increase in values of R.	Rise in temp. of X.
0	3377	...	...
1	...	...	...
2	4370	993	66·20
3	4420	1043	69·53
4	4440	1063	70·87
5	4465	1068	71·20
6	4465	1068	71·20

TABLE VI.—EXPERIMENT 6.—SET 1.

Time in half minutes.	Values of R.	Increase in values of R.	Rise in temp. of X.
0	3377	...	...
1	3580	203	13·53
2	3650	273	18·20
3	3675	298	19·86
4	3678	301	20·07
5	3671	294	19·73
6	3674	297	19·80
7	3674	297	19·80

The next set of experiments had for its object the determination of the law of the relations of different currents, and the temperatures which they were able to maintain.

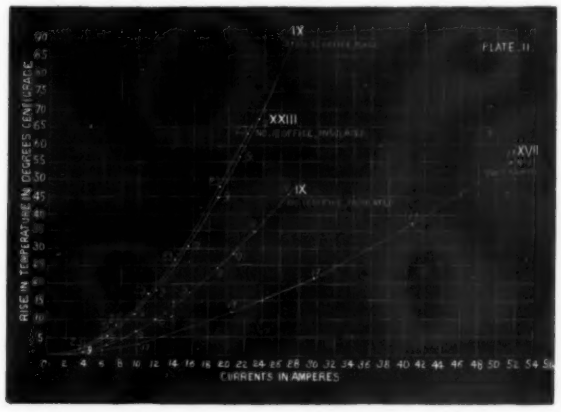
After the current is started in a wire, the emission of heat will increase with the temperature of the wire, until the heat given off just equals the heat developed, when the temperature of the conductor will remain constant. But each current will have its own permanent temperature for any wire under given conditions. To determine the law of this variation, a current was started and allowed to run fifteen or twenty minutes before any observations were taken. Then observations were taken as in the following sample set, the readings of each horizontal line being taken before any of those in the next lower line.

TABLE VII.

R, for bare wire.	R.	R′, for bare + insulated wire.	R′.	Thomson Ammeter.	
				Right.	Left.
4020	4020	8006	8007	0·0	0·0
4195	4198	8338	8343	38·8	41·0
4195	4193	8345	8343	41·0	41·8
4195	4195	8338	8340	40·0	39·3
4193	4190	8330	8330	38·0	38·6
4193	4195	8333	8335	38·8	38·6
Mean of R. 4194		Mean of R′. 8338		39·63	

In the following tables all the experimental data were found by taking the average of a number of determinations similar to the above, and the calculations were made from these averages.

The curves on the cross-section paper, plate II., were laid out by taking the rise in temperature of the wire in degrees Centigrade as ordinates, and the currents in ampères as abscissæ.



Experiments 1, 2, 3, 4, 5, 6, were made with No. 16 wire, all of the same piece, the bare part having been stripped of its insulation, which was a double layer of paraffined cotton. Nos. 1, 2, 3 and 4 were conducted with the two parts of the wire suspended side by side

in a closed room, about 50 feet of each kind being used.

In 5, 6, 7 and 8 the wires were arranged in a similar manner in the open air, the remainder of the apparatus being inside the laboratory.

TABLE VIII.—EXPERIMENT 1.—SET 2.

Resistance of bare wire.	Resistance of both.	Resistance of insul.	Per cent. of increase, resist. of bare.	Rise in temp. of bare.	Per cent. of increase, resist. of ins.	Rise in temp. of ins.	Current in amperes.
4019	7980	3961	0·0	0·0	0·0	0·0	...
4194	8337	4143	4·35	11·5	4·62	12·2	4·62
4279	8470	4190	6·48	17·0	5·72	15·0	8·30
4295	8477	4181	6·56	17·5	5·64	14·6	8·67
4442	8695	4257	10·42	27·4	7·47	19·6	12·17
4593	8938	4340	14·40	37·8	9·57	25·2	16·63
4754	9203	4448	18·31	48·2	12·26	32·3	18·58
5075	9668	4593	26·02	68·4	15·94	41·9	22·00
5013	9582	4569	24·73	65·1	15·09	39·7	22·10
5282	9972	4690	31·42	82·7	18·14	47·1	25·19
5624	10545	4898	40·50	106·6	23·15	60·9	29·29

The observations of the above table were not all taken the same day, so there is some irregularity, owing in part, at least, to changing atmospheric conditions.

TABLE IX.—EXPERIMENT 2.—SET 2.

Resistance of bare wire.	Resistance of both.	Resistance of insul.	Per cent. increase, resist. bare.	Increase in temp. of bare.	Per cent. increase, resist. of ins.	Increase in temp. insul.	Current in amperes.
4240	8405	4165	...	...	...	...	...
4263	8445	4182	0·54	1·4	0·41	1·1	3·29
4330	8539	4209	2·12	5·4	1·05	2·9	6·66
4429	8691	4262	4·46	11·4	2·09	5·3	10·03
4685	9080	4395	10·73	27·5	5·52	14·2	15·85
4966	9508	4542	17·01	43·6	9·05	23·2	19·73
5330	10022	4692	25·71	65·9	12·65	32·4	23·25
5737	10643	4906	35·30	90·5	17·55	45·5	28·09

TABLE X.—EXPERIMENT 3.—SET 2

Resist. bare.	Resist. both.	Resist. insul.	Per cent. increase, resist. bare.	Increase in temp. bare.	Per cent. increase, resist. insul.	Increase in temp. insul.	Current in ampères.
4210	...	4142	...	...	...	...	...
4227	8382	4155	0·41	1·1	0·38	1·0	3·62
4301	8492	4191	2·16	5·7	1·18	3·0	7·04
4389	8634	4245	4·23	11·1	2·48	6·5	9·73
4534	8857	4323	7·69	19·7	4·13	10·6	13·38
4725	9121	4396	12·23	31·3	6·13	15·7	17·03

TABLE XI.—EXPERIMENT 4.—SET 2.

Resist. bare.	Resist. both.	Resist. insul.	Per cent. increase, resist. bare.	Rise in temp. bare.	Per cent. increase, resist. insul.	Rise in temp. insul.	Current in ampères.
4180	...	4172	...	...	...	...	...
4201	8390	4189	0·53	1·4	0·41	1·1	3·22
4309	8546	4237	2·14	5·5	1·15	2·9	6·64
4390	8666	4276	4·52	11·6	2·48	6·5	9·63
4500	8854	4354	7·64	18·3	4·26	10·9	11·84
4717	9144	4427	12·07	30·9	6·01	15·3	15·65
4946	9512	4566	17·52	44·9	9·42	24·5	19·00
5127	9778	4649	21·95	56·3	11·40	28·5	21·00
5328	10088	4760	26·86	67·2	14·04	35·1	23·48
5787	10719	4932	35·40	89·0	18·18	45·5	26·88

TABLE XII.—EXPERIEENT 5.—SET 2.

Resist. insul.	Resist. both.	Resist. bare.	Per cent. increase, resist. bare.	Rise in temp. bare.	Per cent. increase, resist. insul.	Rise in temp. insul.	Current in ampères.
3833	7750	3917	...	...	...	...	...
3846	7783	3937	0·51	1·3	0·34	0·9	4·01
3890	7900	4010	2·37	6·1	1·53	3·9	12·36
3973	8167	4194	7·72	19·8	3·66	9·4	17·18
4260	8776	4507	15·06	38·6	8·57	22·0	27·62

(*Note.*—Experiment 5 of the above set was made during a driving snowstorm, hence the increase in temperature for a given current is less than in any other experiment.)

TABLE XIII.—EXPERIMENT 6.—SET 2.

Resist. bare.	Resist. both.	Resist. insul.	Per cent. increase, resist. bare.	Rise in temp. bare.	Per cent. increase, resist. insul.	Rise in temp. insul.	Current in ampères.
3880	7683	3803	...	...	...	...	...
3901	7736	3835	0·54	1·4	0·88	2·3	3·31
3949	7831	3882	1·77	4·3	2·07	5·3	6·80
4011	7928	3917	3·37	8·6	3·00	7·7	11·64
4029	7963	3934	3·84	9·8	3·45	8·8	14·90
4207	8276	4069	8·42	21·6	6·00	15·4	19·50
5907	10932	5025	53·26	136·6	32·15	82·4	40·83

TABLE XIV.—EXPERIMENT 7.—SET 2.

Resist. bare.	Resist. both.	Resist. insul.	Per cent. increase, resist. bare.	Rise in temp. bare.	Per cent. increase, resist. insul.	Rise in temp. insul.	Current in ampères.
3940	8020	3980	...	...	...	...	...
4222	8285	4063	7·15	18·3	2·09	5·3	16·07
4397	8600	4203	11·34	29·1	5·60	14·3	21·81
4655	9026	4371	17·88	45·8	9·82	25·1	26·90
5122	9730	4608	30·00	76·9	15·78	40·5	33·97

TABLE XV.—EXPERIMENT 8.—SET 2.

Resist. bare.	Resist. both.	Resist. insul.	Per cent. increase, resist. bare.	Rise in temp. bare.	Per cent. increase, resist. insul.	Rise in temp. insul.	Current in ampères.
3950	7890	3940	...	...	...	...	...
4032	8020	3988	2·08	5·3	1·22	3·13	7·96
4118	8174	4056	4·25	10·9	2·94	7·5	13·68
4265	8376	4111	7·97	20·4	4·34	11·1	21·05
4355	8560	4205	10·25	26·3	6·73	17·0	26·93
4902	9350	4448	24·40	62·6	12·89	33·1	34·52

The following experiments in this set (Nos. 9, 10, 11 and 12) were made with a piece of No. 12 "underwriter's wire" alone for X.

TABLE XVI.—EXPERIMENT 9.—SET 2.

Resist. R.	Per cent. increase resist. X.	Rise in temp.	Current in ampères.
2174	0·0	...	...
2187	0·60	1·5	8·15
2214	1·84	4·7	16·17
2264	4·14	10·6	24·16
2330	7·13	18·3	35·13
2398	10·30	26·4	38·93
2560	17·76	45·5	51·95

TABLE XVII.—EXPERIMENT 10.—SET 2.

Resist. R.	Per cent. increase resist.	Rise in temp.	Current in ampères.
2152	...	...	...
2180	1·30	3·3	10·09
2248	4·56	11·7	20·78
2332	8·46	21·9	29·33
2475	15·72	37·7	40·77
2610	21·40	54·9	51·62

TABLE XVIII.—EXPERIMENT 11.—SET 2.

Resist. R.	Per cent. increase resist.	Rise in temp.	Current in ampères.
2146	...	...	..
2164	0·84	2·2	8·22
2214	3·16	8·1	18·41
2307	7·48	19·2	27·22
2461	14·65	37·5	39·89
2683	24·79	63·5	52·69

TABLE XIX.—EXPERIMENT 12.—SET 2.

Resist. R.	Per cent. increase resist.	Rise in temp.	Current in ampères.
2150	...	...	...
2181	1·44	3·7	12·55
2555	18·84	48·3	46·47
2726	26·79	68·7	54·91

TABLE XX.—EXPERIMENT 13.—SET 2.

Resist. R.	Per cent. increase resist.	Rise in temp.	Current in ampères.
6113	...	...	...
6165	0·85	2·2	3·14
6405	4·76	12·2	9·43
7265	18·85	48·3	19·50

TABLE XXI.—EXPERIMENT 14.—SET 2.

Resist. R.	Per cent. increase resist.	Rise in temp.	Current in ampères.
6150	...	...	...
6192	0·68	1·7	3·24
6271	1·95	5·0	6·52
6468	5·17	13·3	10·58
6650	8·11	20·8	13·68
6942	12·88	33·0	16·83
7443	21·02	53·9	21·10

TABLE XXII.—EXPERIMENT 15.—SET 2.

Resist. R.	Per cent. increase resist.	Rise in temp.	Current in ampères.
6075	0·0	0·0	0·0
6236	2·72	7·0	7·47
6754	11·22	28·8	15·19
7439	23·59	60·5	21·37
6115	0·0	0·0	0·0

TABLE XXIII.—EXPERIMENT 16.—SET 2.

Resist. R.	Per cent. increase resist.	Rise in temp.	Current in ampères.
6100	...	...	...
6138	0·63	1·6	3·26
6281	2·96	7·6	7·76
6502	6·59	16·6	11·27
6721	10·34	26·5	14·14
7205	18·11	46·4	19·29
7602	24·62	63·1	22·10

In the above set of experiments, Nos. 13, 14, 15 and 16 were made with No. 18 paraffined office wire, cotton wrapped.

The next set of experiments had for its object the determination of the relation of the diameter of a wire to the temperature at which a current could maintain it. To accomplish this with accuracy it is essential that the changing atmospheric conditions should not introduce a variable factor into the results. To avoid this one wire was taken as a standard, with which all the others were compared. By arranging the two wires as previously described they could be compared under exactly similar surroundings; and the standard wire in each set of experiments would show any change in atmospheric conditions and permit of corrections being made.

The diameters of the wires were determined by measuring with a micrometer screw gauge reading to ten thousandths of an inch. Each diameter was measured 10 times in different parts of the wire, and the average of these 10 readings is the one given in the tables. R, R′, and the Thomson ammeter were each read 50 times, and values in the tables are in every case the average of 50 observations. By laying off the diameter in mils as abscissæ and the temperatures as ordinates, we get a curve representing the desired relations.

Another set of experiments had for its object the determination of the effect of an insulating covering upon the temperature which a current would maintain. In order to have as few inaccuracies as possible, Prof. Anthony obtained, through the courtesy of the manufacturers, wire in lengths of about 100 feet, of which half of each size was covered with their ordinary insulating material, the other half being left bare. The dimensions given are the average of 10 readings on the micrometer screw gauge reading to tenths of a mil, and the values of R, R′, and the readings of the ammeter are the averages of thirty observations. Deductions from the results are made later, after the theoretical discussion of this problem has been given.

Having given the data of experiments and the results derived therefrom, it now remains to compare these results with those obtained from theoretical considerations or by other experimenters. From the definitions of the C.G.S. system of electrical units, one volt-ampère or watt $= 10^7$ ergs $= \frac{1}{9{\cdot}81}$ kilogrammetres. But $C\,E = C^2\,R$; hence the work done by a current, C, in passing through a resistance, R (C in ampères and R in ohms), $= C^2R$ watts $= \frac{C^2R}{9{\cdot}81}$ kilogrammetres per second. Since this energy is all converted into heat, we have the heat developed in a conductor $= \frac{C^2R}{9{\cdot}81}$ kilogrammetres $= \frac{C^2R}{9{\cdot}81 \times {\cdot}424}$ calories, since one calorie (lesser) equals ·424 kilogrammetres.

(To be continued.)

Primary Battery Lighting.—For the past fortnight Messrs. Swete and Main have maintained a small installation, consisting of six 20 C.P. Edison and Swan incandescent lamps, worked from a Regent primary battery at 16, Austin Friars.

REPORT ON THE EXPERIMENTS OF M. MARCEL DEPREZ RELATING TO THE TRANSMISSION OF POWER BETWEEN CREIL AND PARIS.

By M. MAURICE LEVY.

(*Continued from page* 165.)

Calibration of the instruments of measurement and actual measurement of the resistances.—Since February last, at which date regular work was commenced, the engineers of the Northern of France Railway and the electricians specially attached to the experiments executed daily the electric and dynamometric measurements necessary for the determination of the yield obtained, so that the commission found the measuring instruments all ready. Before making use of them it has been necessary to ascertain their correctness, and effect the calibration of each instrument.

This was the first operation: — At Creil they had to calibrate—

(*a.*) For the mechanical measurements two dynamometers of White's system, mutually identical and serving to measure the motive work furnished by the two locomotives.

(*b.*) For the electric measurements two ampèremeters, with proportional deviations on the Deprez system, intended the one to measure the current of the rings, and the other the current of the inductors, and a potentiometer on the same system for measuring the difference of potential at the extremities of the generator.

At La Chapelle:—

(*a.*) From a mechanical point of view a Prony brake to measure the useful work collected.

(*b.*) From an electrical point of view the same instruments as at Creil.

The constants of the galvanometers were determined by Cornu's method, already employed at the experiments at the Northern Station.

The dynamometers were calibrated by means of Prony's brake.

This verification, the results of which are given in Table I., showed the perfect accuracy of the measuring instruments employed, as well as of the special co-efficients of each.

The differences between the results obtained by the Commission and the mean results of the numerous observations executed daily by the engineers attached to the inquiry fall throughout within the limit of errors of observation.

The exactness of the instruments being recognised, we measured the resistances of the machines and the line, using the ordinary method with Wheatstone's bridge. The results are given in Table II.

Practical experiments in transmission.—These preliminary operations having been completed on May 24th, one party of the sub-committee went to Creil and the other party to La Chapelle to make the experiments on transmission. The results are to be found in Table I. We operated by varying the speed of the generator from 168 to 218 rotations per minute; its electromotive force varied from a minimum of 4,887 volts to a maximum of 6,290 volts.

The power consumed at Creil varied (omitting fractions) from 67 to 116 horse-power, and that recovered at Paris from 27 to 52 horse-power.

The yield increases with the power transmitted.—The industrial yield has varied from 40·78 to 44·81 or about 41 to 45 per cent. With the exception of a slight anomaly in experiment 3, it increases with the horse-power transmitted, which depends on sensibly constant losses, such as those necessitated by the magnetic fields, which are like the general outlay of the operation. They become less and less sensible as we operate on a larger scale.

Thus the most important experiment, in which we took 116 horse-power at Creil and recovered 52 at Paris, was the one which gave the greatest yield, 45 per cent. The fact that we can thus practically transmit 116 gross horse-power to a distance of 56 kilometres and derive an industrial yield of 45 per cent., accurately measured, not exceeding a velocity of 218 rotations of the generator, and this continuously, without straining the machines, is an extremely remarkable result which could not easily be expected and which must be emphatically pointed out.

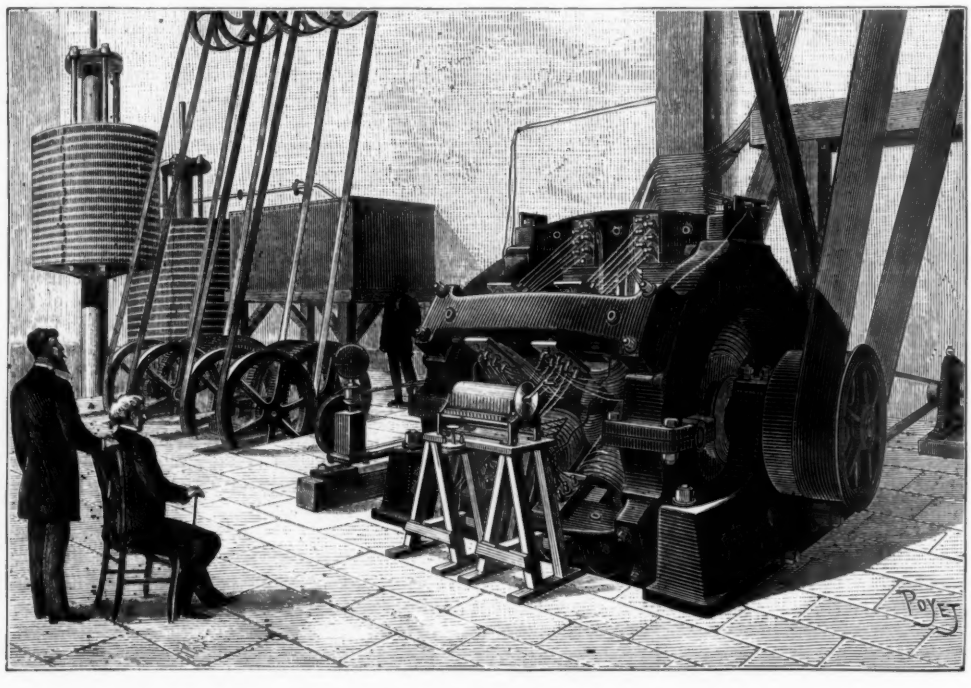


FIG. 1.—MARCEL DEPREZ'S EXPERIMENTS BETWEEN CREIL AND PARIS.
VIEW OF THE RECEIVING APPARATUS AT THE STATION OF LA CHAPELLE. (From *La Nature.*)

Discussion.—It is not sufficient to establish the bare fact of a yield of 45 per cent. It is necessary to find out how the 55 per cent. of force lost was consumed. It was evidently lost, partly by the machines and partly by the line.

Work absorbed by the generator.—The work communicated to the generator was 116 horse-power. The difference of the potentials at the extremities of the machine is 6,004 volts. The intensity of the current is 9·789 ampères.

The available work at the extremities of the generator is therefore expressed in horse-power

$$\frac{6004 \times 9{\cdot}879}{75 \times g} = \frac{6004 \times 9{\cdot}879}{735{\cdot}66} = 80{\cdot}4 \text{ horse-power.}$$

The loss of work in the generator is therefore 116 − 80 = 35·6 horse-power.

Work absorbed by the recipient.—The differences of the potentials at the extremities of the recipient is 5,456 volts; the intensity of the current there is 9·824 ampères; the work which the recipient receives, expressed in horse-power, is therefore:—

	Horse-power.
$\frac{5456 \times 9{\cdot}824}{735{\cdot}66}$, or, say	73·1
The useful work recovered at its exit is ...	52·1
Work lost by the recipient	21·0

Work absorbed by the line.—The available work having been found:—

	Horse-power.
At the end of the generator	80·4
At the end of the recipient	73·1
The work lost on the line is	7·3

But the figure obtained in this manner would not merit any confidence. In fact it results from the difference of two very large numbers. However little we may have been deceived in the observations relating to each of them the relative error committed in their difference may be of the same rank as the difference itself. This is the more true as we must remember that all the measures taken are industrial, and not measurements of precision.

It is, therefore, indispensable to determine the loss of the line directly. The loss in horse-power is the product of the resistance of the line and of the square of the mean intensity of the current divided by 75 g.

The resistance of the line (Table II.) being 95·45 ohms and the mean current (Table I.) 9·85 ampères, the work sought for is

$$\frac{97{\cdot}45 \times 9{\cdot}85^2}{75 \cdot g} = \frac{97{\cdot}45 \times 97{\cdot}02}{735{\cdot}66} = \frac{9454{\cdot}60}{735{\cdot}66}$$

=	12·7
in place of	7·3
found above, or a difference of	5·4

The total loss determined by the dynamometer and the brake being 116 − 52 = 64 horse-power, the total loss by the machines must be 64 − 12·7 = 51·3 horse-power in place of 56·6 horse-power determined electrically.

If we share this difference between the two machines we shall arrive finally at the following figures:

	Horse-power.
Loss in generator ... ... $\frac{35{\cdot}6 \times 51{\cdot}3}{56{\cdot}6}$ =	32·2
Loss in recipient ... ... $\frac{21{\cdot}1 \times 51{\cdot}3}{56{\cdot}6}$ =	19·1
Loss in line	12·7
Total	64·0

We thus see that the loss in the line is trifling, and that the machines consume the most of the power. Hence we are led to put the question, what is the industrial value of the machines constructed by M. Deprez? To render the discussion definite, we must especially consider the machine at Creil being the most important in dimensions and that which best answers to the present ideas of the inventor, and we shall discuss the most important experiment, that which consumed 100 horse-power at Creil.

Examination of the industrial value of the Creil machine.—Such a machine may be considered from four points of view:—

1. As regards the qualities of its inductors or of its magnetic field.
2. As to the qualities of its rings.
3. As to the qualities of the entire machine or of its industrial yield.
4. As to its mechanical qualities.

These latter qualities we have recognised by the facility of constructing and repairing the machine, its massive dimensions and the slowness of its movements. We need not return to this subject.

Economic value of its magnetic field.—If we cause it to move, in a magnetic field of the length of 1 metre, at the rate of 1 metre per second, there arises in the wire an electromotive force which may serve as a measure for the intensity of the field.

It is merely requisite to multiply the number of volts which constitute this electromotive force by 10^4 to have the measure of the field in centimetre-gramme-second units.

But the intensity alone does not constitute the economic value of a magnetic field. Its volume intervenes, likewise, in the magnitude of the effects which may be obtained. This volume in a dynamo machine is comprised between the two concentric cylinders which limit the inductors and the cores.

In the Creil machine, the distance between the cylindric surfaces limiting the inductors and the core of the armature is 0·06 metre. The mean circumference of the annular volume occupied by the field has a diameter of 0·74 metre. The breadth of the field of each ring, equal to the breadth of the core of the ring is 0·40 metre. Hence the volume of the fields of the two rings is

$$v = 2 \times \pi \times 0{\cdot}74 \times 0{\cdot}06 \times 0{\cdot}40$$

or $v = 111$ cubic decimetres approximately.

On the other hand, always taking the most important experiment, that where 116 horse-power is consumed, the electromotive force developed by the field in the ring of the generator is 6,290 volts, the speed being 218 turns per minute.

The ring is divided into 196 sections, or one of the halves comprised between the brushes $\frac{196}{2} = 98$ sections, having each 20 metres of useful wire (50 strands of 0·40 metre in length).

The total length of useful wire is therefore

$$98 \times 20 = 1{,}960.$$

The mean circumference described having 0·74 metre in diameter or 2·32 metres in circumference, the surface described by the wire in a rotation of the ring is

$$1{,}960 \times 2{\cdot}32 = 4{,}547 \text{ square metres, or for the two rings}$$
$$2 \times 4{,}547 = 9{,}094 \text{ square metres.}$$

As the speed is 218 turns per minute, the surface described per second is

$$\frac{9{,}094 \times 218}{60} = 33{,}041 \text{ square metres.}$$

The electromotive force being 6,290 volts, we obtain per unit of velocity

$$\frac{6{,}290}{33{,}041} = 0{\cdot}190 \text{ volts.}$$

Therefore in centimetre-gramme-second units the field is

$$H = 0{\cdot}190 \times 10^4 = 1{,}900 \text{ units.}$$

Let us now value the crude force which must have been expended to obtain it. The experiments (Table III.) show that with a current of 36 ampères in the exciter, a current very close to that of 36·30 existing in the magnetic field relating to the transmission experiment which we are examining, the work observed at the dynamometer necessary to set the exciter in action has been 12·68 horse-power.

Thus, in fine, the Creil generator yields a magnetic field of 1,900 units of the volume of 111 cubic decimetres by means of 12·68 horse-power.

Comparison with the magnetic field of the Gramme machine (Model A).—Let us make the same calculation with the Gramme machine. To obtain a field of 1,900—2,000 units, there is required in this machine a current of 20 ampères traversing an inductor circuit, the resistance of which is 0·6 ohm.

The work expended is therefore

$$\frac{0{\cdot}6 \times 20^2}{75\,g} = \frac{0{\cdot}6 \times 20^2}{736} = 0{\cdot}326 \text{ horse-power.}$$

The dimensions of the field in the Gramme machine are the following:—

Annular thickness of the field	0·01 metre.
Mean length of circumference	0·55 „
Breadth of the iron core	0·10 „

and hence, for the volume of the field,

$$v = 0{\cdot}55 \times 0{\cdot}10 \times 0{\cdot}01 = 0{\cdot}55 \text{ square decimetres,}$$

or about $\frac{1}{206}$ of that of the Creil machine.

Therefore, to produce a field of the same intensity and volume as that of Creil, 200 Gramme machines would be required.

As each of these expends 0·326 horse-power, the total power required would be

$$200 \times 0{\cdot}326 = 65 \text{ horse-power,}$$

in place of the 12·60 horse-power consumed at Creil. Five times more power would be required.

Besides, the weight of the copper in each Gramme machine of the A model is about 30 kilos., the consumption of copper, therefore, would be 6,000 kilos. in place of the 2,534 kilos. required in the Deprez machine.

We see, therefore, that as regards the creation of the magnetic field the large inductors employed by M. Deprez are exceedingly advantageous.

2. *Value of the copper rings.*—The ring of a dynamo machine is so much the more perfect as there is produced less parasitic work, i.e., work other than that which may be collected at the brushes. Such is the work absorbed by Foucault currents in the iron cores and by phenomena of self-induction produced twice in each revolution in each section of the ring.

But there may be other causes of loss of work which have not been analysed, or resulting from faults of construction in the ring.

Let us call T_i the work thus lost by known or unknown causes; T_m the crude motor work furnished and measured at the dynamometer; T_e the portion of this work devoted to the exciter; T_f that consumed by passive mechanical resistances, such as the friction of the axle of the machine and of the brushes, stiffness of the driving belts, vibrations, &c.

The value of the work really supplied to the ring is

$$T_m - T - T_f - T_i$$

But this work, as we know, is equal to the product $\frac{E\,I}{75\,g}$ of the electromotive force and the current divided by 75 g. We have then in strictness

$$T_m - T - T_f - T_i = \frac{E\,I}{75\,g}$$

whence

$$\frac{\frac{E\,I}{75\,g}}{T_m - T - T} = 1 - \frac{T}{T_m - T_e - T_f}.$$

If the ring were perfect, and if none of the parasitic wor designated by T_i existed, the first quantity would be unity.

The value of this first quantity, always less than unity, is tha commonly called the *coefficient of transformation of the machin* and might be more correctly named the *yield of the ring.* Th

ring is, indeed, so much more perfect the nearer this value approaches to unity.

Let us establish, as we have done for the magnetic field, a comparison between the ring of the Gramme machine (model A) and that of Creil.

The electromotive force of the Creil machine, expressed in horse-power, is $\frac{E\,I}{75\,g} = \frac{6290 \times 9{\cdot}879}{735{\cdot}66} = 84{\cdot}5$ horse-power.

The motive power is

$$T_m = 116 \text{ horse-power.}$$

On the other hand (Table III.), at a speed of 208 revolutions, the work absorbed by friction (open circuit) is 9·38 horse-power, which for 218 revolutions will be

$$T_f = \frac{218}{208} \times 9{\cdot}38 = 9{\cdot}85 \text{ horse-power.}$$

The work absorbed by the exciter in action (with the current of 36 ampères, which is approximately that of our experiment) is

$$T_e = 12{\cdot}68 \text{ horse-power.}$$

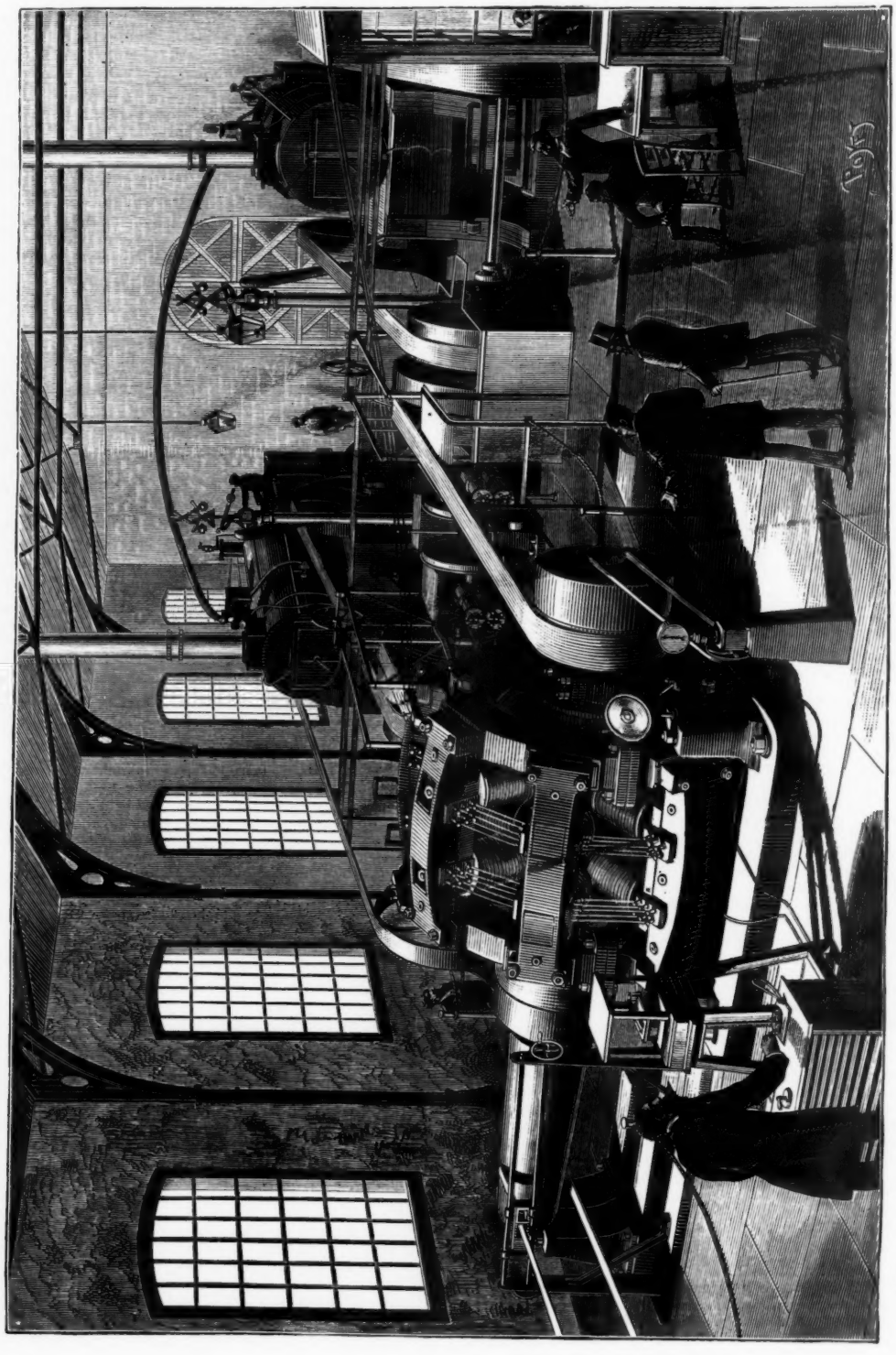


FIG. 2.—MARCEL DEPREZ'S EXPERIMENTS BETWEEN CREIL AND PARIS. VIEW OF THE GENERATING APPARATUS AT CREIL STATION. (From *La Nature.*)

whence

$$T_m - T_e - T_f = 116 - 12{\cdot}68 - 9{\cdot}85 = 93{\cdot}47$$

and for the co-efficient of transformation

$$\frac{84{\cdot}5}{93{\cdot}47} = 0{\cdot}90.$$

Comparison with the Gramme ring (Model A)—The machine,

Model A, according to the experiments made at the 1881 Exhibition by MM. Tresca and Poitier, an analogous yield.

Hence it results that the Creil ring, notwithstanding its large dimensions and the great length of wire contained in each section, and which might seem likely to increase the phenomena of self-induction in an excessive proportion, is as perfect as smaller rings.

In fine, like the production of the magnetic field, the arrangements adopted by Marcel Deprez are highly advantageous; on the other hand his ring furnishes the same yield as that of the Gramme machines (workshop model), and that with a much less velocity and a great convenience for construction and repairs.

3. *Industrial yield of the Creil machine.*—After having studied each of the two parts (inducers and armature) of the Creil machine, let us take it in its totality so as to show its effective yield.

We define generally the yield of a dynamo machine by the ratio

$$\frac{\frac{E\,I}{75\,g}}{T_m}$$

of its electric work to the motive power supplied to it. This yield, in the experiment before us, would be

$$\frac{84{\cdot}5}{116} = 0{\cdot}725$$

or about 0·73.

But what concerns the industrialist is not the electric work of a generating machine, but the work collected at its extremities compared with that supplied to it. The yield thus understood—the least favourable case which can be considered—is the ratio.

$$\frac{\frac{\varepsilon\,I}{75\,g}}{T_m} = \frac{6004 \times 9{\cdot}879}{785{\cdot}66 \times 116}$$

ε being the difference of potential at the extremities of the machine.

We obtain here 0·70, or about 30 per cent. of loss. This figure is probably excessive, since, on calculating the loss due to the line, we have seen that the losses due to the machines are, in fact, a little less than those appearing from the electric observations.

We have found that the loss of the generator is 32·2 horse-power out of 116 received, or

$$\frac{32{\cdot}2}{116} = 27{\cdot}7, \text{ or say 28 per cent.},$$

which would leave a yield of 0·723, or about 72 per cent. The engineers of M. Deprez have found 73 to 74 per cent. Let us admit the maximum loss of 28 per cent.; it is distributed thus:—

Of 116 motive horse-power supplied 9·85 have been lost in friction, stiffness of driving-belts, &c., 12·68 are expended in moving the exciter; the surplus is transformed into heat upon the ring.

Hence the losses incurred at the generator may thus be summarised:—

	Per cent.
1. Mechanical losses (friction, vibration, &c.) ...	8.5
2. Power spent in producing magnetic field ...	11·0
3. Heating of the ring	8·5
Total	28

Industrial yield of the machine at La Chapelle.—For a recipient the industrial yield (understood also in the least favourable sense) is the ratio of the power which it absorbs at its extremities to that which it furnishes to the brake on the axle of its ring. The numerical results of Table I. indicate, in the experiment in question, that the yield thus understood is 76·5 per cent.

Industrial yield of the two machines connected.—From the dynamometric experiments there appears with certainty a loss of 64 horse-power. And as the line absorbs 12·7 horse-power, the two machines together absorb 51·3.

Hence it results that in any transmission of power, however trifling the distance, from the mere fact that we are obliged to employ two machines we cannot, with the speed of 200 rotations admitted at Criel, an electro-motive force of about 6,290 volts and separate excitement count on a yield of more than

$$1 - \frac{51{\cdot}3}{116} = \frac{64{\cdot}7}{116} = 55{\cdot}43 \text{ per cent.}$$

The mean yield of each of the two machines accurately observed is therefore

$$\sqrt{0{\cdot}5543} = 74 \text{ per cent.}$$

which is sensibly conformable to the result obtained for each of them.

From the yield of 0·5543, or in round numbers 55 per cent. furnished by the two machines connected, it is necessary to deduct in each case the work lost on the line.

Conclusions.—1. We may now affirm the possibility of transmitting with a single generator and a single recipient to a distance of 56 kilometres an industrially utilisable force of about 52 horse-power with a yield of 45 per cent. without exceeding a current of 10 ampères, an angular speed of 216 revolutions per minute or a circumferential speed of 7½ metres per second.

If we take account of the power absorbed by the dynamometers and other instruments of measurement, by the driving bands and the appliances arranged with the view of facilitating the experiments or of ascertaining the best proportions to be adopted for the organs of transmission, all matters which would not exist in industrial applications, we may say from the present that in practice the yield will be very close upon 50 per cent.

Of the loss of 55 per cent. the two machines with their exciters have absorbed about 45 per cent., and the line about 10 per cent.

In any case the line will absorb more or less according as a thicker or thinner wire is employed.

If we have abundance of cheap power at command and consequently do not attach much importance to the yield, we employ a thin wire which will render the installation more economical, but will absorb more power.

If, on the contrary, the power at disposal is limited, and it is requisite to draw from it the greatest possible advantage, economy in the first outlay must be sacrificed by adopting a thick wire. Here is an ordinary problem for the engineer to solve, according to the circumstances of each case.

2. The working of the machines is now exceedingly satisfactory, both as regards regularity and continuance.

Since February they have been worked for a mean of five hours daily and up to nine hours without serious heating, burning the wires or producing sparks at the brushes.

3. The speed of the generator when consuming 116 horse-power is only 216 turns per minute and that of the recipient 295 turns. These are industrial speeds with which we could scarcely expect to produce so great effects, and it is a striking sight to see a dynamo moving so slowly and yet so powerful, that at each rotation of its rings mechanical power of 1,000 to 1,200 kilogrammetres becomes industrially available at the distance of 56 kilometres.

4. The maximum electromotive force is 6,290 volts.

The danger resulting from the employment of such tensions is one of the principal objections which are urged against these experiments as regards their application to ordinary practice.

We believe that this is a prejudice which should not be allowed to become established.

The experiments at Creil have lasted for more than six months; it is the first time that the persons employed have had to manage such tensions and yet we have not had the slightest accident to deplore, which proves that with due precautions the dangers may be overcome.

Besides, all human industries, without exception, are full of dangers, especially in their commencement.

As they are developed the danger declines, though without ever disappearing. There are always junctures where fatality will triumph over human foresight. These sad moments man accepts as episodes without influence upon the main result of his struggle against natural forces.

The catastrophes which, in spite of the improvements adopted, still meet us in the two greatest industries of the world—in railways and in navigation—hinder no one from profiting by their benefits.

It will be the same for the transmission of power if it gives the results which we are now permitted to hope.

5. Another fear inspired by the use of high tensions, springs from the losses of electricity, which they may facilitate on the way.

Experiment, which alone can here decide, has not justified these fears which theory rendered admissible.

In all weathers the resistance of the line has remained approximately constant at equal temperatures, and the difference of the currents of Creil and of La Chapelle has always been very slight. This may be judged by the figures in Table I.

6. If we admit a velocity of 300 turns in place of 200, which appears quite feasible, and which in the conviction of M. Deprez can be widely realised, we may, without even increasing the electromotive force, gain considerably in the yield simply by diminishing the resistance of the rings.

M. Deprez thus hopes to exceed the yield of 50 per cent. which he announced at first.

The more decidedly will this be the case if we agree to increase the electromotive force, which can be done without augmenting the weight of copper of the machines and without altering their speed. M. Deprez regards such a result as realisable. But on this experiment has not yet decided.

7. As regards the wire, the Commission considers that it may be left bare for its entire length except at its entrance into and its exit from the workshops, provided that it is everywhere conveyed out of reach of the hand and at a distance of at least three-quarters to one metre from telegraph or telephone wires, so that whatever wind may prevail, it cannot be entangled with them nor produce upon them any effect of induction.

8. The cost of an installation of transmission cannot, of course, be founded upon the expenditure incurred in the experiments where everything had to be created. The Commission has nevertheless obtained information on the transmission of 50 horse-power between Paris and Creil with the tensions furnished by these experiments.

It appears that the price may be fixed thus:

	Francs.
Generator machine	50,000
Recipient machine	30,000
Line 56 kilometres, estimated at 800 francs per kilometre going and returning...	44,800
	124,800

(To be continued.)

INCANDESCENT LAMP PATENTS.

EDISON *v.* WOODHOUSE AND RAWSON
AND
EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY *v.* WOODHOUSE AND RAWSON.

(*Before* MR. JUSTICE BUTT, *sitting for* MR. JUSTICE NORTH.)

(*Continued from page* 163.)

Monday, May 17th, 1886—(*continued*).

The SOLICITOR-GENERAL then addressed the judge, saying that it appeared to him the main point in the case was whether a man was entitled to have a patent for substituting what he was pleased to call a carbon filament for what he was pleased to call a carbon pencil in the Swan lamp. He said he was not. Could Edison say to Swan, I will not allow you to reduce the size of your carbon burner; I will not allow you (if flexibility entered into the question, which the Solicitor-General denied), to make your carbon conductor of a material more flexible than that which you at present employ for the purpose, and I will claim a monopoly of all incandescent carbon lamps in which the burner is of such small sectional area and of such an amount of flexibility as I think fit to give the name of carbon filament to? That was his learned friend's contention, stripped of all the fine scientific language in which it had been wrapped up. The combination of vacuum-sealed wires, glass globe, and carbon burner being well-known, could a man, without describing any new process whatever, any new way of using that machine, by proposing to use it in precisely the same way as it was used by Swan and other persons, by passing a current of electricity through the conductor and rendering it incandescent, could a man by doing that claim to himself a monopoly of that machine when made with one part of it of a particular size? He submitted that he could not. His lordship had heard a great deal of evidence on one side or the other, but he did not think there was any great conflict of evidence as to what a filament was. As he said in his opening, he was content to take Dr. Hopkinson's description of it, who described it in language evidently carefully chosen as having a small sectional area. He ventured to submit that that was not proper subject matter for a patent. Of course a man might have a patent for a new mode of making a carbon burner; of course he might have a patent for a new mode of working a carbon incandescent lamp. He (the Solicitor-General) was not scientific enough to suggest an illustration of what he meant, but the point of the case seemed to him to be this, that the combination described in the second claim was precisely the same combination as that to be found in Swan's lamp, with the single substitution that one part of that combination was made with a smaller sectional area than Swan used. If he spoke to his lordship for two or three hours he could not get beyond that. In the case of Kaye *v.* Marshall, which had been referred to, something definite was given. The patentee defined the limits to which you might go. At any rate, the patentee said this, you shall not reduce the space between certain parts of your machine more than 2½ inches. But that element was absent in this case. He asked, where could there be infringement? They had it in evidence that these filaments, as they were called, were of all degrees of sizes as regards sectional area, and of all degrees of flexibility as regards rigidity. There was no bounding place where you could say this patent of Mr. Edison began or where it ended. The evidence of Mr. Rawson, to his view, was extremely illustrative of the case. He told them that he made lamps of all sizes, that the burners all operated in the same way as in Swan's, and that these burners were of all degrees of thinness as regards sectional area, from a hair in one of those beautiful little lamps he showed his lordship up to something considerably thicker than the pencil in Swan's lamp in the large ones, and that there was no resting place between the two, that the gradations were insensible, and that it was a mere matter of degree upwards. What judge would undertake to say, under these circumstances, whether this or the other lamp was an infringement of the second claim of Edison's? His learned friends could not say that Edison defined the size which you could or which you could not take. That would be one thing. He (the Solicitor-General) did not think it would have improved his case; but he did not say that. His learned friends said, you shall not use any carbon between 100 and 500 ohms resistance; but Edison was careful not to make that part of his patent. Mr. Edison himself said that the wire might be rolled out to various lengths and diameters. What lengths? what diameters? A manufacturer had a right to be told, if a man claimed a monopoly, what the monopoly was for. It was not enough to tell him that it was for a carbon filament of various lengths and diameters. He did not suppose his learned friends would rely upon the point of resistance, for in that case the patent was merely for a lamp of a particular resistance. It was quite true that the consequence of a small sectional area was a lamp of high resistance. All the scientific world and the practical electrical world knew that, and they had been told it before the date of Mr. Edison's patent. If it came to that, that carbon filament meant having mere high resistance, he asked again what was high resistance? Mr. Rawson had told them that he made lamps of every degree of resistance, from very high to comparatively low. A man could not have a patent for that, and Edison did not claim that. He claimed a carbon filament which might have that effect, but he did not claim it as such. In other words, his patent was for nothing more than substituting what he was pleased to call a filament for the burner in Swan's lamp, or, in other words, reducing the sectional area. They might talk for an hour and twist the subject round and round and obscure it or elucidate it, whichever might be the effect of the scientific evidence, but the result would be that it would still be nothing more than reducing the sectional area. The Solicitor-General then proceeded to deal with the other alleged anticipations, and, in conclusion, said with regard to the second claim that it appeared to him his learned friends were in this dilemma: if the construction was, as he thought they might easily argue it was, a claim to a combination of which one element was carbon filaments, made as described by Edison, his answer would be, it may or may not be a good patent, but I have not infringed it. On the other hand, if they said the second claim was larger, being a claim to a combination in which carbon filaments, made in any way in which they were capable of being made, new or old, good, bad or indifferent, then he said the claim was too large, and then it amounted to this, a mere claim to a combination which was not new, the only difference in the combination being that the burner was reduced in size. If it was to be construed in that large sense, then undoubtedly the defendants did use as burners in their lamp something which might be not improperly described as a carbon filament, although not made as described by Edison. It seemed to him that the plaintiffs were in this dilemma, they must construe the claim in such a way that they (the defendants) should not infringe it, or if they gave it a larger construction and endeavoured to sweep within their net all vacuum incandescent lamps, then the claim was too large.

Mr. ASTON said the Solicitor-General had narrowed the many questions which appeared to be raised at an earlier stage of the case down to one or two, and placed those in a form in which each one might be dealt with very shortly and very thoroughly. The Solicitor-General had practically admitted infringement of the second claim, if that claim was to be construed in the way in which the plaintiffs submitted it ought to be construed. Therefore with regard to infringement, as he should venture to contend that the second claim ought to be construed in the wide sense in which it was opened by Sir Richard Webster, if that was the proper construction his lordship would have nothing to decide with reference to that part of the case, inasmuch as the infringement was admitted.

Mr. JUSTICE BUTT: Let me understand. So far as I see there is no evidence of any infringement of the first claim. Does it not not really come down very much to the question of the second? Assuming that I should say that filament means any filament, any carbon filament, it amounts to a question, is that a proper and valid subject matter for a patent? That is what it reduces itself to. Of course the Solicitor-General has referred to one or two other claims, and says they are invalid.

Mr. ASTON said if carbon filament was to be construed in the way they said it should, namely, a carbon filament such as as described by Edison, then its presence in every one of the claiming clauses would cause each clause, and certainly each claim, to be new, and the only question ought to be, having regard to the carbons which were sticks or pencils or rods, might there be a valid patent for carbon filaments? His lordship had asked if there was any evidence as to the first claim. He should rely upon the answer that, under some pressure, he obtained from Mr. Rawson. Mr. Rawson said he did secure his filament to his platinum terminals, and he told them how it was done. He should submit that there was evidence of infringement for his lordship to consider even of the first claim. It was denied by his friends on the other side, but even whether there was infringement on the first claim or not, inasmuch as the question for his lordship to decide was not whether there was infringement of claim one, two, or three, but whether there was infringement of the patent, it did not matter whether the infringement was proved singly, doubly, or trebly. The Solicitor-General said the matter was reduced to a very small point: could Edison say, I will not allow a carbon filament that is flexible to be substituted by anybody for——

The SOLICITOR-GENERAL: I did not admit that flexibility enters into it.

Mr. ASTON: The Solicitor-General did say, even if it is.

The SOLICITOR-GENERAL: What I meant was, that the only scientific definition of a filament is the small sectional area. It is a consequence of its having a small sectional area that it is also flexible; but I intended my argument to be as to the small sectional area.

Mr. ASTON said he should not be contented to give up flexibility as being a characteristic of the carbon filament. He would lay before his lordship the character of the filament, the form of the filament, the substance of which the filament was made, each and every one points of the utmost importance as regards the working of an electric lamp. It would be idle for them to shut their eyes to the fact that from the time of King in 1845 downwards, constant attempts had been made by various persons to solve the problem how to produce an incandescent lamp, and it was very curious how, although the right material was hit upon as early as 1845, to wit, carbon, people went away from carbon; they tried metals of various kinds, of various densities, of various fusibility as regards the capability of resisting heat, and, just to refer to them in general, there were some attempts made with carbons that were filed by a saw to be made thin, but these were abandoned. Then somebody came back again to various forms of carbon. Pulvermacher wanted to use a form of carbon, and he placed a coil of carbon round a rod of carbon, separating the two

by an insulator, and allowing the two points of his carbon spiral and carbon central spill so to be brought together that the current would leap over, and so make the arc light. Then Van Choate said, I will put in an electric wire a carbon which is coiled in some way or other, and I do not tell you how to make it, and by the incandescence of that carbon I will get a light. He did not say he would surround it by a lamp, he did not say how he would make his spiral, he did not call it filament, he did not say it was to have the characteristics of a filament, but he said a spiral wire of carbon of the proper size. It was quite clear that Van Choate, who only deposited a provisional specification, and never told the world his *modus operandi*, told nothing. It was a mere speculation, as far as it went, and only amounted to this, that if you got carbon in some way or other into the form of a spiral, and made that spiral incandescent, you would get a light; that was to say, you would get an incandescent spiral. Everybody knew that. He did not go beyond that and show in what useful form it was to be employed. He did not even say anything about a glass vessel or a vacuum. Harrison and Scott went no further. Scott said when sticks or rods are to be made they are to be made in a certain way; he again proposes to use carbon, but by incorporating with the carbon asbestos or fibres of hemp or other organic fibres, and then he says, take care you do not destroy those fibres when you use them; do not carbonise them. Thus, although in 1878 Scott fell back again upon the original carbon, he did not know how to deal with it, and was far away from solving the problem. Harrison did not help the matter, because he said, what I will do will be to have a thread or filament of silk or cotton treated with an acid to make it a nitro-cellulose substance, something like gun cotton, coat it with carbon, and then use that as a means to obtain electric light between electrodes or burners of any suitable kind by means of induced currents. He did not say that he proposed to put those in a glass globe; he did not say that he proposed to exhaust that globe. In fact, he again was as far from anything like an incandescent lamp as were Van Choate and Scott; and what was more, the witnesses for the plaintiff had said that if there had been, you could not have passed a current through the gun-cotton like material, because it was not a conductor, and if you attempted to force anything through it would cause a mild explosion. Lane-Fox made many attempts at solving the problem. He said, "I use iridium, platinum, a combination of metals." In fact, he went back to metals, and thought he had solved the problem. But the curious part was that he was not satisfied with his metal conductor. His first conductor was an alloy of platinum and iridium in lengths of fine wire. Then, the defendants said, he got high resistance. He (Mr. Aston) admitted that he was on the right track. He got high resistance; he got a current that he could subdivide. Then this curious thing happened, that after he had described a lamp and tried to make it and work it for years, it turned out that it was useless. In fact, all metallic wires, so far as was known, had proved of no practical utility. Lane-Fox found that out, and accordingly disclaimed from his patent all about his electric lamp, and it became public property. Well then, what did he do in his next specification? Metallic wires were wrong; he would go back again if he could to carbon. His lordship would remember that in his specification he mentioned what he called his bridge of non-conducting material. Did he employ a carbon filament? Nothing of the kind. He said: "I also use asbestos or other suitable non-conducting material saturated with some refractory, conducting material, such as carbon or iridium." He came back again now to carbon, evidently thinking that carbon was the right thing. And so it was, only he could not get it in the right shape. In another provisional specification in November, 1878, Lane-Fox proposed to use a lamp, but when he came to his complete specification he dropped out all reference to the lamp, and only claimed an apparatus for regulating the distribution of electric currents. Thus, up to the end of 1878, they found that five or six persons had been using carbon, but all had been obliged to give up. Pulvermacher also came in the year 1878, on November 23rd, but he was a long way off. The defendants said, if anybody had taken Pulvermacher's spiral and connected it with platinum wires and put it into an exhausted glass globe, would he not have had Edison's lamp? Yes, he would; but nobody told him how to do it. In March, 1879, Lane-Fox tried again to get some form of carbon, but *the* little thing had yet to be discovered, the apex had yet to be put to the pyramid. Mr. Aston then proceeded to deal with the lectures of Mr. Swan. On February 18th, 1879, Mr. Swan said that what was required to make electric lighting successful was an electric lamp in which there was no waste of carbon and no machinery, meaning thereby, no such complicated machinery as shutting off the current, and so forth. Mr. Edison said he had invented such a lamp, and Mr. Sawyer said he had. If what those gentlemen said were true, they would not have long to wait for a very extended development of electric lighting. Even if it should happen that those inventors had not accomplished so much as people had been led to expect, the problem of a simple and economical lamp, he did not doubt, would be ultimately solved, and with its solution electricity would become a common means of illumination. Was that the language, continued Mr. Aston, that an inventor who had a successful incandescent lamp before him, of which he had been speaking, might be expected to use?

Mr. JUSTICE BUTT: Is not the answer to that, that it was before running the pumps?

Mr. ASTON: That has nothing to do with running the pumps.

Mr. JUSTICE BUTT: But he did not know the operation of running the pumps at this time?

Mr. ASTON: "Up to this time I have called attention to the fact that the rod itself became bent and softened." That is the objection, and the only objection, so far, to which Mr. Swan has called attention.

Mr. JUSTICE BUTT: I do not think you follow me. You see clearly this is an imperfect lamp, and therefore Mr. Swan did not patent it. It occurs to my mind that it might have been imperfect in another respect which might have prevented his patenting it. I mean it does not follow that he did not patent it because the conductor was not perfect.

Mr. ASTON: I admit that; but it had materially to do with it. —Proceeding, Mr. Aston referred to the paper respecting Mr. Swan's lamp which was read by Mr. Procter on December 18th, 1879, after the date of Edison's patent. The lamp referred to was a globe of glass containing a rod of carbon whose dimensions were given; a current of electricity passed through the rod and raised it to a state of intense incandescence, and even bent it in such a manner as suggested that it had perhaps been softened by intense heat. There was the first point alleged, the commencement of deterioration of the conductor and the commencement of disintegration and destruction of its utility as a conductor. Then Mr. Procter referred to the sooty deposit which, no doubt, was caused by running the pumps. He (Mr. Aston) quite admitted that these descriptions were publications, but he would ask his lordship to bear in mind that case to which Sir Richard Webster had called attention, Hills *v.* Evans, where Lord Westbury, sitting as Lord Chancellor on appeal, laid it down that the information contained in a prior publication must be such as to enable the patented invention to be performed Having quoted other cases bearing upon the point, Mr. Aston said that even if there were no judicial decisions which went to that extent, he did not think the court would dissent from the proposition that a patent could only be voided by a prior publication which told a man as much as the patent did, and which was tantamount to the description which, without experiment, would enable the patented invention to be carried into effect. The question was put to every witness: Reading Swan's description, is there anything which tells you to put into Swan's lamp that which Edison describes as a carbon filament? And the answer was: No. Does Swan describe anything else than that which has such rigidity that, under expansion due to the heat, it becomes bent? No. Then he (Mr. Aston) would say, there was nothing in Swan which would tell anybody how to make an Edison lamp. Therefore there was no prior publication. The Solicitor-General, with all his acute intelligence and experience brought to bear upon the point, did not succeed in controverting that proposition, and he was driven to another, which was very ingenious and, as they might expect, coming from the Solicitor-General supported by very able arguments. It was this: Carbon known, wire known, carbon sticks or rods known; you could not prevent a man from putting in the same lamp——

The SOLICITOR-GENERAL: I said carbon conductors.

Mr. ASTON meant so to say. Carbon conductors known, carbon conductors in the form of rods known, because he could not carry it higher than that. No one of Her Majesty's subjects ought to have been prevented from taking a carbon rod and reducing its sectional area. Now, that was a very plausible statement, but let them consider in what form the carbon rods were that had been dealt with.

Mr. JUSTICE BUTT: Does he not say, Carbon filament known?

Mr. ASTON: There he would have been wrong.

Mr. JUSTICE BUTT: How about Sidot?

Mr. ASTON: I ought to have said carbon filament in an electric lamp. Sidot I shall have to deal with by itself.

Mr. JUSTICE BUTT: Then there is Pulvermacher. There was a filament produced by one of the defendant's witnesses which he had manufactured from Pulvermacher's specification.

Mr. ASTON said those were written descriptions. In Otto *v.* Linford Lord Justice Brett said: "Then what is the rule when you rely upon a description in writing by an anticipation? It seems to me that it is not sufficient to say that if a machine were made by a person who had read that writing, something in that machine would, if it had been really a machine used, have been by reason of that user, an anticipation of the plaintiff's patent. You must go further, and where you allege that an anticipation is in writing, and in writing only, you must show that a person, meaning a person conversant with such matters, reading that writing, would find in it a reasonably clear description of the plaintiff's invention in that writing alone. If it requires that a machine should be made in order that the anticipation may be seen, a subsequent inventor is not obliged, when his attention is called to a mere writing, to make a machine from it in order to see what will be the effect of that machine. He has to find a description of his own invention on the face of that writing, construing that writing reasonably as an invention." That seemed to be the effect of the judgment in the case of Hills *v.* Evans, and also in the case of Betts *v.* Neilson. A specification which was relied upon as an anticipation of an invention must give the same knowledge as the specification of the invention itself. Applying that to this case, did Sidot tell the public to take one of the things he described, a thread for example, and put it in an incandescent lamp? No. He did not suggest it, and he invited his lordship to hold that there was no direction in Sidot to make an incandescent lamp such as Edison described.

Mr. JUSTICE BUTT: That is clear enough; that is not contended, but he says there is a process described which gives your very filament.

The SOLICITOR-GENERAL: Suitable for use in an electric lamp.

Mr. ASTON: Yes. It could be useful in the same way as a Bunsen conductor. But if Sidot went beyond the fact that it was a filament, and if he told them that it could be used for an electric light, how was it nobody had put it in an incandescent light? Sidot did not tell them how to do it.

Mr. JUSTICE BUTT said he did not quite know how far Sidot in the *Comptes Rendus* could be taken as a publication. A publication in one sense it was, but he was not writing on electric lighting at all. Was an inventor in this country to know everything that was written?

The SOLICITOR-GENERAL: It is assumed that he may know it. As I understand the theory of publication it is not necessary to prove that he does know it. If it is so far published that it has become part of the stock of public knowledge, that is to say, the knowledge of scientific men engaged in any way in the subject, then it is publication. It has been held that if it is in the Patent Office Library in this country and accessible, that is sufficient proof of publication.

Mr. JUSTICE BUTT: I am assuming all that, that it is published and open to the inspection of every person in this country. Still I do not know how far an inventor is bound to know everything in a foreign language which is published in this country.

Mr. ASTON: That is it, my lord, that is it. But I am going to ask your lordship whether, applying the dicta of Lords Justices Holker and Brett——

Mr. JUSTICE BUTT: That is quite another point altogether, and assuming that you are wrong on that, I daresay this must be taken as a prior publication. I am only trying to ascertain what the rule is.

Mr. ASTON: I admit that all the statements in this ought to be accepted, according to the decisions of your lordship's predecessors, as showing that what Sidot states becomes part and parcel of public knowledge.

Mr. JUSTICE BUTT: So long as you admit it I am satisfied, but what was passing in my mind was, supposing a man is writing upon one subject and hints at another in one part of his paper, how far is that to be taken as publication?

The SOLICITOR-GENERAL: Then I should conceive the question to be, whether it is suggested sufficiently to put people on the track of what he has done?

Mr. ASTON: I cannot help thinking the difficulty quite got rid of if we apply the dicta of these learned judges. Does Sidot tell the public that which you find announced and described in Edison's specification?

Mr. JUSTICE BUTT: That is another point. But as you admit that this is a publication, it must be taken as known to Edison, and that is the end of my question.

Mr. ASTON said he would distinguish the cases of Sidot and Pulvermacher, and every other to which his lordship's attention had been called, from all cases of prior publication that had upset a patent, because here there was no description of the patented article, nor any directions to make the patented article. Pulvermacher was describing an arc lamp, and he said, coil your rod, which is a substantial rod, round your centre core, separate the coil rod from the centre core by an insulator, and let the top or extreme end of your coiled rod form one of the points from which incandescence is produced. He did not say, diminish the sectional area and join the two ends of it to two terminals, and put those two terminals sealed in a glass globe, and exhaust as much as you can, for if he did he would have told you how to make an Edison lamp.

Mr. JUSTICE BUTT: That is not quite clear. That spiral in his patent is insulated from the carbon core. That being so, it is Edison's carbon spiral. It is very true, you do not attach it to platinum wires.

Mr. ASTON said he was going, when he came to the claiming clauses, to satisfy his lordship, he hoped, that there was no claim to the filament point of it. That point of the filament was new, but there was no claim upon which the patentee staked the validity of his patent by claiming a filament *qua* filament as a new thing; that was to say, he could not go into the market and prevent people from making and selling his carbon filaments, he could not go to the manufacturer who supplied Messrs. Woodhouse and Rawson and say, you have a lot of filaments in your shop, and I shall stop you from selling them. He had not claimed the filament. But when Messrs. Woodhouse and Rawson followed the directions given by Edison, and put that filament into an incandescent lamp under the conditions stated by Edison, then they fell foul of the second claim.

Mr. JUSTICE BUTT: But wait a moment; does he not claim it?

Mr. ASTON: No, my lord. It is arranged as described, as set forth.

Mr. JUSTICE BUTT: In such a manner that only certain portions can radiate light.

Mr. ASTON: Exactly so. And under those circumstances he had asked the witnesses, Does not fig. 1 show the way in which Edison arranges his spiral as set forth? The witness said, Yes. Therefore he had not a claim, as the Solicitor-General put it, to spiral *per se*, but only to the spiral as arranged so as to radiate light. And how was the light to be got? Why, it must be put into a globe. Then, how was it put into a globe? Why, as shown in fig. 1. Which showed what? Why, the arrangement. He was going to contend that all these claiming clauses respectively claimed the combination which was described by Edison, and if he had claimed his carbon filament *per se*, if he had claimed his spiral *per se*, he would not have used such words in connection with it, as associated with its environment. It was shown in the picture, and referred to as being able to radiate light in the body of the specification. How could that be unless it was, as admitted by Mr. Rawson, as shown in fig. 1? Having referred again to the Otto gas engine case, Mr. Aston continued: Let me apply that to Pulvermacher. Does he show that he wanted to attenuate his spiral rod in order to make it serve as a conductor. No, his mind is in altogether another direction, and it will not do for my friends to make a Pulvermacher lamp and to take out of that his coiled rod, as Dr. Frankland did with very great ingenuity, and say, I will attenuate that; I will deprive it of its character, such as it possesses when Pulvermacher describes it, and I will make it into a filament. Pulvermacher does not tell them to do that. It would be inconsistent with the utility of Pulvermacher's rod spiral if he made it into a filament. Dr. Frankland admitted that it must have a substantial area in order to get a substantial arc. I asked him whether you could not pass the current both ways, from the core to the coiled rod and from the rod to the core. He said, Yes, possibly. I meant to do it both ways. "Then is it not inconsistent with his description that you must attenuate that rod and bring it down to a filament?—Yes." And I submit to your lordship that unless you read in Pulvermacher's directions that which would, if followed out, enable Edison's lamp to be made, it must be put in the category of Johnson (the alleged anticipator in the Otto case).

(To be continued.)

NOTES.

Covent Garden Lighting.—Last Saturday evening brought with it the commencement of the Promenade Concert season. The electric lighting of Covent Garden Theatre is this year in the hands of Messrs. Paterson and Cooper, who may be congratulated on making so successful a first night's show, as the work had to be completed in much less time than has been allowed in previous years. The Pilsen arc lamps in the Floral Hall were simply perfection in their steadiness, and we have little doubt that the present installation will compare very favourably with its predecessors. The number of arc and incandescent lamps employed have already been stated in our columns, and we may now add that five "Phœnix" dynamos, driven by a Marshall's engine, are in position to produce the current. These machines ran admirably, and with the least sparking we ever remember to have seen.

Domestic Electric Lighting.—A Bromsgrove paper states that the well-known château at Impney, the local seat of Mr. John Corbett, M.P. for the Droitwich division of Worcestershire, has lately been supplied with the only addition requisite to render it one of the most elegant and perfect residences in the country, viz., the electric light. The selection of this method of illumination has been attended with the best results, the decorations and works of art showing to their greatest advantage under the influence of the incandescence lights. The motive power for driving these lights consists of a turbine situated about 250 yards from the residence, and supplied with water by the river Salwarpe running through the park and having a fall of 13 feet. The application of turbines for this purpose, though not entirely novel, has hitherto been confined to localities where a much greater fall of water is obtainable, but the lighting of the chateau exclusively proves that even with a small fall sufficient power is obtainable to light a very large mansion. The dynamo used in this instance is placed in the turbine house, and the current thus generated is conveyed by means of cables buried in the earth to the accumulator room, situated in the basement of the mansion. This installation is said to be one of the most successful extant, and the fullest advantage has been taken by the contractors of the facilities afforded them in carrying out their work. The contract was placed in the hands of Messrs. Nicholson and Jennings, of London, and was carried out under the personal supervision of Mr. E. J. Jennings.

Electric Lighting and Photography.—Messrs. Blomfield & Co., photographers, of Hastings, devote special attention, according to a local paper, to the use of the electric light. Mr. Blomfield utilises a large circular

screen in such a manner that he concentrates the rays from his lamp, which is globeless, and directs them upon any desired object, thus taking photographs as well by night as by day. The electric light is also used for copying purposes, as it serves better than ordinary daylight, being more steady and even.

Will the electric ever supersede the limelight for the lantern? is a query which the *British Journal of Photography* has just put to itself. Our contemporary proceeds to remark that there is no question that, for large exhibitions, where the arc light is available, the illumination is all that can be desired, and it entails but little trouble. With the glow lamp some capital effects have been shown where a primary battery has been employed, but, unfortunately, when the battery is exhausted, the discharging and recharging of it is a somewhat troublesome and not at all an agreeable operation—solutions containing chromic acid are by no means pleasant ones to deal with; moreover, some little knowledge of electricity is necessary, and this is not possessed by every lanternist. The time and trouble of replenishing the battery will always have to be set off against the trouble of making a supply of oxygen. Some very convenient forms of batteries have recently been described, but the trouble alluded to, our contemporary has been "given to understand," will at present militate against their very general adoption for lantern purposes. There are now, however, the writer goes on to say, some exceedingly portable secondary batteries which may prove useful, but they require to be charged by a dynamo, which few amateurs possess. If there were a demand, electricity would, doubtless, soon become an article of commerce in every town, and then the battery could easily be recharged. But here, again, the battery would have to compete with the bottle of compressed oxygen, which is also an article of commerce and equally convenient.

Thomson-Houston Lamps on Towers.—The first Thomson-Houston lights on towers, according to exchanges, have just blazed out at Jacksonville, Ill. The plant is run by the gas company, and the lights are mounted on six of the Star Tower Company's iron towers.

Electric Lighting in Cornwall.—Mr. J. E. Veale is carrying on an electric lighting campaign in the far south-west, and has now established himself at St. Austell, where, from accounts which have reached us respecting the failure there of the gas supply on several recent occasions, he is not unlikely to meet with a favourable consideration of his proposals. Last week Mr. Coon, manager at St. Austell for Mr. Veale, made the market house look brighter than its wont on the occasion of the holding of a flower show within its walls. The market is a large one, and on three different levels; the central and largest was lit by 38 Edison-Swan lamps, which created a good effect; the lowest level was occupied by an artificial garden with flower beds and a fountain, and Mr. Coon's aid was called in for the ornamentation and illumination of these with coloured lamps. A miniature imitation of the South Kensington illuminated fountain was attempted, and succeeded to the intense admiration of the Cornish folk. Lamps of 100 C.P. were placed in specially constructed lanterns by means of which the water was coloured at will, ruby, green, or blue. The current was supplied from the central station which Mr. Veale has erected for town lighting purposes, and which, on the completion of a large storage battery now in course of construction, will be ready for general supply.

The Electric Lighting at the Saltaire Palace of Delight.—In March last we remarked, upon information which had been supplied us, that the public opinion of outside lighting must have been severely shaken in the Bradford district by the failure which occurred in connection with the lighting of the building operations at the Saltaire Palace of Delight. The name of the Woodhouse and Rawson Electric Contract and Maintenance Company having at an early period been mentioned in connection with the lighting of the Palace, that company has written to the governors of the Salt Schools with the purpose of clearing itself from any misapprehension which may have arisen, and has received the following reply from the secretary:—"In reply to your letter dated 30th ult., in which you draw the attention of the Governors of the Salt Schools to a statement which has been publicly made that the temporary electric lights which were fitted up last winter to light the building operations at their new Science Art and Schools were a failure, I am, in accordance with your request, to assure you (1) that the lamps and apparatus were not furnished by your company; and (2) that they were fitted up under the direction of the governors, and were not a failure."

Telephonic Communication in the Isle of Wight.—The Western Counties and South Wales Telephone Company has recently extended its wide-reaching operations to Newport, in the Isle of Wight, and the corporation of that town has affixed the common seal to an agreement with the company as to the erection of poles, and the carrying of wires in and over high roads in the borough.

Telephonic.—At the last meeting of the Edinburgh Chamber of Commerce, it was agreed, on the motion of Mr. Wilson, that a letter should be addressed to the Postmaster-General on the subject of the Government taking over the telephones, and expressing the opinion of the Chamber on the matter.

The Regent Primary Battery.—On Tuesday, Mr. Maquay gave a demonstration of his battery at the offices of the Regent Primary Battery Company, 17, Craven Street, Charing Cross. A box, 11 by 10 by 6 inches, containing 24 cells, maintained a lamp of about 15 C.P. very steadily, and was guaranteed to work without attention for eight hours. A compact miner's lamp was shown weighing only 2 lbs. 11 ozs., being less than that of the Davy lamp, and yet affording double its illuminating power for an equal length of time without refilling. Professor Fleming has reported very favourably on the battery, as follows:—"Experiments were made by me with the small set of 24 cells. It was set up, and made to supply current to a 40 volt incandescent lamp. The current and electromotive force at the terminals of the lamp were measured every five minutes for six hours by corrected instruments. During the first two hours there was a drop in electromotive force amounting to about 5 per cent. From the end of the second hour to the end of the sixth the current and electromotive force remained absolutely constant, and the closest inspection did not reveal any change in the reading of the instruments. This is certainly a very remarkable result for cells of this small size. During this time the battery was delivering energy at the rate of 30 watts, and hence, in the six hours' run, delivered 180 watt hours, or about 500,000 foot pounds of energy. During the time the consumption of active plates was about 3 ozs. weight in all. At the end of the run the positive plates were as bright and untarnished as when first put in the battery. The cost of electrical energy obtained from such a battery would be approximately about 1d. per 40 watt hours. This means that a 16 candle glow lamp could be maintained in action for about six hours for 6d." The report goes on to say: "In addition, I may say that I regard the alloy as used for the positive plates in the Regent battery as a very valuable invention. With a little modification this battery should have large uses in telegraphy and other operations where a constant battery of high electromotive force is required."

Next week we shall probably give Professor Fleming's report in full. We are pleased to see that he thinks so highly of the battery which he believes will meet requirements not yet supplied by any existing forms, for it is not against the invention that our previous remarks have been directed, but to the

manner in which the tests, prior to those of Professor Fleming, were conducted. Had the proprietors of the Maquay battery obtained reports from competent scientific men in the first place, our strictures, it now appears, would have been considerably modified, if indeed, made at all.

The Edison and Swan United Electric Light Company, Limited.—On Saturday last, the 14th inst., many of the employès of this firm took part in their annual excursion. Through the kindness of the London, Chatham and Dover Railway Company they were allowed to travel by the continental express from Victoria Station at 8 a.m. to Dover, and at one o'clock sat down to a substantial repast provided for them by Mr. Philpott at the "Royal Oak" Hotel. In the regretted absence of Major S. Flood Page, the secretary and manager of the company, and also of Mr. Alexander B. Blackburn, the resident engineer, Mr. Hill presided. After dinner the usual toasts were drank, which included "the success of the firm" and "the health of the management," these particularly being received with enthusiasm. The afternoon and evening were well spent in visiting the various attractions in and about this interesting old town and district. With favourable weather the journey back to town closed a most enjoyable day at Dover.

Electric Lighting at Harrogate.—The Hydropathic establishment at Harrogate has just been successfully lighted by electricity by Messrs. Thompson, Dowsing and Rew. The installation consists of fifty-three 20 C.P. incandescent lamps, and two of 40 C.P., supplied by a Crompton-Bürgin dynamo, which is driven by the engine used in the daytime for working the laundry.

The Telephone in Venezuela.—The Venezuela Telephone Company has at Caracas a telephone exchange of 500 lines, and uses the multiple switchboard of the Western Electric Company. Incandescent electric lamps are provided for the night operators, the Volta-Pavia batteries furnishing the electricity for the lamps.

"Shallow" and the Telegraph.—The *Military Bulletin* says:—We have heard it asked, why it is that local magnates oppose the erection of Government telegraph lines? The only satisfactory solution seems to be that they act on the principle of the nigger, described by Hans Breitmann, who when asked why he kicked his pig, replied, "Cos I dam please, and to show my tortority."

To Incandescent Lampmakers.—Those interested in the incandescent lamp trade must not forget that Thursday next is the day appointed for the meeting, convened by Messrs. Shippey Brothers, to be held in the Cannon Street Hotel.

Another Electric Launch.—An experiment of a more than usually interesting description took place on the River Cart at Paisley, last Friday afternoon, when a screw launch propelled by electricity was tested. The designer, Mr. James Gibson, Cartha Works, Paisley, claims that it furnishes an easy means of locomotion, and that it has the additional recommendation that in working it will be found to be cheaper than a steam engine giving a similar result in the way of speed. The vessel on which it was tried was of small dimensions, only having a length of about 24 feet and a breadth of beam of 5 feet 3 inches. Secondary cells are used as a motive power, and in this case they were specially brought from London for use. The current is sent through an armature, on the spindle of which is placed square-cut gearing, which reduces the initial velocity from 1,500 revolutions per minute to 230—a speed which sufficed to move the launch at the rate of rather more than seven miles an hour. Another method by which Mr. Gibson has found the power can be satisfactorily communicated is by friction pulleys, which, in order to enable the person to increase or diminish the speed of the vessel as circumstances may dictate, take the form of cones. One of these, measuring 12 inches in length and tapering from 4 inches in diameter down to 2, is placed on the armature spindle, while another of the same length, but having a diameter tapering from 14 to 12 inches, is fitted on the shaft of the propeller. These cones are about three inches apart, and have their surfaces parallel and three inches from each other. The intervening space is filled up with a nest of three smaller cones, which bear on the larger ones, and by moving which to the large or small end of the other cones it is possible to control the speed of the vessel. The invention may be utilised for other purposes than that of the propulsion of vessels. For instance, it may be applied to tramway cars; indeed, says the *Glasgow Herald*, it is in this connection that it is believed it will be found most valuable.

A Congregation in the Dark.—The service at St. Andrew's Church, Plymouth, was interrupted on the night of the 15th inst. by a most unexpected occurrence. The edifice contained an exceedingly large congregation, and as the prayers preceding the sermon were about to conclude, the gas, by which the chancel is lighted, gave a sudden flutter and almost immediately afterwards went out. This occasioned much consternation amongst the congregation, and several left the church as hurriedly as possible. The vergers proceeded to the meter which supplies the chancel with gas, and after a little delay succeeded in lighting the gas. By this time it was presumed that about 100 people had vacated their seats. The service was then continued.

Improvements in Electric Wire.—We learn that an improved bronze wire for telegraph, telephone, and other electrical purposes is being introduced by Mr. F. Geere Howard. Its tensile strength and high conductivity permit the substitution of this wire, weighing about 36 lbs. per mile, instead of 380 lbs. per mile of iron. It is an inoxidisable wire, and can be used on spans of 400 yards. A remarkable property or quality of the wire is that it is manufactured so that it has exactly the same conductivity and strength throughout any length.

An Electrician in Trouble.—At West Ham Police Court on Tuesday, Louis Hendle, 36, described as an electrician, of 45, Lawrance Street, Canning Town, was charged on a warrant with obtaining 22s. on July 1st and £6 on July 2nd, from Joseph Ryan, a wardrobe shop keeper, with intent to cheat and defraud. Prisoner represented that he was a doctor, and he said he would cure a bad hand which Mrs. Ryan had. He supplied her with medicine, and was paid each time he brought it, but he had not been paid for the last, nor for a bar of soap he brought for her to wash her hands with. On Thursday morning, July 1st, he called on Mrs. Ryan and said that he was connected with the electric lights at Charing Cross. He asked for the loan of 22s. to assist in his work, and this sum he said would fetch him in £200. The money was lent him, and the next morning he called on prosecutrix "in a hurry" and asked if she could get any one else to lend him £6 to help the work forward. He said he would willingly give £3 for every one of the sovereigns, as the sum would bring him in £400 when the work of the electric light of Charing Cross was completed. Mrs. Ryan said she knew no one who could lend him the money, but, with the consent of her husband, she took £6 from her stock money, and her husband handed it over to him. He promised to repay the loan in a fortnight's time, but repeated applications for the repayment of the money were met with various excuses, one being, on July 22nd, that he had a cheque for £50, but could not change it for three days. He promised at the end of the three days to give her the money back and pay her for her kindness, and he left her some papers, which he said were valuable documents which he could not keep at his lodgings as there were children there. —The prisoner was remanded.

The Atlantic Cable War.—In a circular which it has just issued, the Commercial Cable Company, after quoting from the remarks of the chairmen of the Direct and Anglo-American Companies made at the recent meetings of those companies, says: "The last reports of the allied companies point out the great increase of traffic as a result of the adoption of the 6d. tariff. Granted the number of words transmitted by their cables has more than doubled, the receipts have fallen to one-half of what they were last year; thus the situation remains the same as when Lord Monck explained it at the beginning of this year, that is to say, they will have to adopt every possible means to return to a tariff exceeding 1s. 8d. The public should have no hesitation in choosing between the vague promises of the allied companies and the formal affirmation of the Commercial Cable Company. By continuing to support the latter company the public will acquire the certainty of the tariff never being increased to 3s. Our patrons will also understand that their earnest support will induce the Commercial Cable Company to lay a third cable and to still further reduce the tariff of 1s. 8d., which this company has undertaken never to exceed."

The Utility of Overhead Wires.—One of the big buildings adjoining the Stock Exchange, New York, United States, is known as the Mortimer, one of the handsomest in the street. Recently workmen were engaged on its roof, when one of them, Charles M'Donald, stumbled when carrying a lighted blowpipe in one hand and a can of benzine in another. There was an explosion, and in a moment M'Donald's clothing was all aflame. One roof of the Stock Exchange was two or three storeys below, and M'Donald determined to reach that and then get by a trap door to the street. A rope dangled from the Mortimer Buildings roof to the Stock Exchange below, and the burning man jumped forward to grasp it. He made a miscalculation, and missed the rope, and shot down through the air, the flames gaining force as he went. Fellow workmen who saw the accident waited breathlessly to see him dashed to pieces below, but a long line of telegraph wires were stretched across his downward path and he struck fairly upon them. They gave way a little under the force of his weight and the power of his fall, but instead of breaking and letting him dash on to speedy death, they bounded upward, and there in mid-air, once, twice, and three times, poor M'Donald, the centre of scorching, brilliant flames, swung up and swung up, all helpless, but finally he fell somewhat sidewise, and the wires threw him over the Stock Exchange roof, only a foot or two beneath. Men ran to his rescue. The flames were extinguished, and the poor fellow was taken to a room below, where, after he had spent three-quarters of an hour of intense suffering, an ambulance responded to the call which had been sent out promptly after the accident. The flesh of his right arm was burned almost completely off, and portions of his body were crisp. Yet the doctors thought he would live under careful nursing.

The "Volta."—On Saturday afternoon we had the privilege of making a most enjoyable trip from Charing Cross Pier to Hammersmith Bridge and back, on board Mr. Reckenzaun's electric launch, the *Volta*. We were much pleased with her performance, for Mr. Reckenzaun has now brought every detail of the electrical navigation of small boats to such perfection, that no hitch of any kind is likely to occur. Messrs. Stephens, Smith & Co., of Millwall, deserve every praise for the strong and substantial manner in which they have constructed the Reckenzaun motors. A short notice of the trial trip of the *Volta* appeared in our last issue.

Medical Electrical Appliances.—During the meeting of the British Medical Association at Brighton last week, the Electric Apparatus Company had on view in the Museum Section a highly attractive collection of medical appliances, including a newly-designed electric cautery, inductorium, constant current and voltaic batteries, photophores, bull's eye and head lamps, which were all highly commended. The company also exhibited an electric ophthalmoscope, worked by means of a small Victoria set; this instrument, being designed for the examination of the eye, was well tested by several eye specialists, and it met with their approval.

Arc Lights in Boston.—The Brush Electric Light Company of Boston reports a continued increase of orders for arc lights of its system, both for city and commercial lighting. The number of arc lights in actual use on July 15th was reported at 750, which it is said will probably be increased to over 900 before October 1st. At the company's magnificent station on Ferdinand Street depot, 21 dynamos and six steam engines are in use; five of the latter are of the Armington and Sims make, of 175 H.P. each, and one is a Fitchburg, of 75 H.P. A new 250 H.P. steam engine, two new boilers and several dynamos are to be added to the present equipment.

NEW COMPANY REGISTERED.

John Fowler and Company (Leeds), Limited.—Capital £680,000 in £10 shares. Objects: To take over the engineering business of the firm of John Fowler and Company, of the Steam Plough Works, Leeds. The business to be carried on will include civil engineering in all branches, and also the special businesses of hydraulic and telegraph engineers, and generally all descriptions of special engineering operations, including the manufacture of wire and other cables, appliances and apparatus connected with electric telegraph, electric lighting, and for making electricity or other energy. Signatories (with one share each): *Robert Fowler, A. Fowler and W. McIntosh, of 6, Lombard Street; *David Greig, *R. W. Edison and R. Wigram, of Leeds; and J. Gurney Fowler, of Woodford, Essex. Directing qualification, 500 shares. The first directors are the signatories whose names are preceded by an asterisk. Registered 13th inst., by Messrs. Wilson, Bristows and Carpmael, 1, Copthall Buildings, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Jablochkoff and General Electricity Company, Limited.—The annual return of this company, made up to the 9th of March, was filed on the 16th March. The nominal capital is £20,000 in £100 shares. 80 shares are taken up and the full amount has been called and paid thereon, the paid-up capital thus showing an increase of £500 as compared with the previous return.

Australasian Electric Light and Power Company, Limited.—At an extraordinary general meeting of this company, held at 41, Coleman Street, on the 11th June, resolutions were passed authorising the increase of the capital of the company by the addition thereto of the sum of £69,026 beyond the registered capital of £255,000, including therein 34,513 ordinary and 34,513 preferred shares of £1 each. The new ordinary shares are to be issued as fully paid, and will rank for dividend *pari passu* with the original shares, but on a winding up, they will only rank against assets to the extent of £17,256 10s. (that is to say, to the extent of 10s. in the £) until the 26,366 original shares are paid in full, after which they rank to their full nominal amount. An indenture dated 20th May, 1886, between Edison's Indian and Colonial Electric Company, Limited, of the first part, Thomas Alva Edison, of Menlo Park, New Jersey, U.S.A., of the second part, and the company of the third part, was also adopted. The resolutions were confirmed at a meeting held on the 28th June, and were duly registered on the 12th inst.

The annual return of the company, made up to the 25th June, was filed on 12th inst. The nominal capital at the time of making up was £255,000 in 50,000 shares of £5 each, 31,000 of which are taken up. Upon 24,000 shares £4 per share has been called, 7,000 are issued as fully paid. The total calls received amount to £95,025 17s. 6d. and £35,000 is considered as paid. The calls unpaid amount to £974 2s. 6d. Upon 15 shares forfeited, the sum of £45 has been received.

Electric Metal Extracting, Refining and Plating Company, Limited.—An agreement dated 30th June, provides for the purchase by this company from Thomas Veasey, of 76, Finsbury Pavement, the patent right No. 2,557 and 4,723 of 1886, for refining, separating and recovering by electro process, tin, copper and other metals and alloys, from scrap and old metals, dross, slags, and mining tailings; and for electro-galvanising iron goods. The consideration is 25,000 fully paid £1 shares and £5,000 in cash. Messrs. T. Veasey & Co. are appointed consulting engineers to the company for five years. The purchase includes a lease of a factory, and electric apparatus and appliances.

Edison-Gower-Bell Telephone Company of Europe, Limited.—The annual return of this company, made up to the 14th April, was filed on the 21st April. The nominal capital is £500,000 in £1 shares. 385,009 shares are taken up and the full amount has been called thereon. The calls paid amount to £15,005, and unpaid to £4. 370,000 shares are considered as fully paid up.

LEGAL.

Field v. Bennett.—In the Queen's Bench Division, on Thursday last week, before the Lord Chief Justice and Mr. Justice Denman, the further hearing of the arguments in this case was concluded. The action was one brought for libel by Mr. Cyrus Field, against Mr. James Gordon Bennett, the proprietor of the *New York Herald*, and judgment having gone by default against Mr. Bennett, the jury at the Middlesex Sheriff's Court assessed the damages at £5,000. The question now before the court was whether that judgment and all subsequent proceedings should be set aside for irregularity, on the ground that the writ had not been served on the defendant, and that he was an alien, domiciled in Paris, beyond the jurisdiction of the court. The learned judges granted an *interim* injunction to stay execution pending the delivery of their judgment after the recess in October next.

CITY NOTES.

Lancashire and Cheshire Telephonic Exchange Company, Limited.—The directors have decided to recommend a dividend of 7 per cent., and to carry £2,000 to the reserve fund.

TRAFFIC RECEIPTS.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 15th August are £1,669, as compared with £2,191 in the corresponding period of 1885.

NEW PATENTS—1886.

9991. "Electric batteries." H. ARON. Dated August 4.

10006. "Electro-motors." A. SCHANSCHIEFF. Dated August 4.

10030. "Magnetometers." A. MILLAR. Dated August 5.

10050. "Incandescent electric lamps." P. M. JUSTICE. (Communicated by A. Cruto.) Dated August 5. (*Complete.*)

10092. "Adjustable mechanical electrical indicator." F. A. STEVENS. Dated August 6.

10097. "Electrical railway signalling apparatus." H. H. LAKE. (Communicated by L. Clémandot.) Dated August 6.

10137. "Facilitating the erection of telegraph, telephone, or other such wires or cables." G. A. GRINDLE." Dated August 9.

10185. "Applying electricity for ventilating and cooling on board ship." J. STEPHENS, A. SMITH. Dated August 10.

10186. "Electric generators." C. W. HILL. Dated August 10.

10204. "Railway electric safety signals." O. HUGHES. Dated August 10. (*Complete.*)

10217. "Electric telegraph keys." A. J. BOULT. (Communicated by R. A. Macready.) Dated August 10. (*Complete.*)

10222. "Voltaic batteries." E. ANDREOLI. (Communicated by J. V. Warnon.) Dated August 10.

10242. "Electro-magnetic locks for safes, &c." H. H. LAKE. (Communicated by F. Sedgwick.) Dated August 10. (*Complete.*)

10286. "Voltaic batteries." F. H. W. HIGGINS. Dated August 11.

10292. "Lighting railway and other carriages by electricity." J. A. FLEMING, C. H. GIMINGHAM. Dated August 11.

10307. "Instruments for measuring and recording electric currents." W. GREENHALGH. Dated August 12.

10319. "Secondary batteries." W. HABERLEIN. Dated August 12.

10331. "Regulators for electric arc lights." A. J. BOULT. (Communicated by S. Doubrava.) Dated August 12.

10334. "Dynamo dermiques plates as electric generators for nervous affections." E. MORON, E. LEGRAS. Dated August 12.

10393. "Conduits, ways or cases for electrical conductors, &c." T. O. CALLENDER, C. E. WEBBER. Dated August 13.

10404. "Telephonic systems and apparatus." J. Y. JOHNSON. (Communicated by A. M. Rosebrugh.) Dated August 13.

10451. "Multiple telegraphy and apparatus therefor." W. R. LAKE. (Communicated by A. M. A. Beale.) Dated August 14. (*Complete.*)

10477. "Depositing platinum by electricity." W. A. THOMS. Dated August 16.

10497. "Receiving and conveying messages." T. J. HEWSON. Dated August 16.

10499. "Telegraph keys." J. M. BIGGS. Dated August 16.

10502. "Electrical storage batteries." E. FRANKLAND. Dated August 16.

10508. "Automatic electric liquid level indicator and controller." J. J. GHEGAN. Dated August 17. (*Complete.*)

10536. "Composition of matter to be used as an electric battery excitant." E. D. KENDALL. (*Complete.*)

10566. "Insulators for mechanical telephones." C. H. MARTIN. Dated August 18.

10569. "Hermetically sealing electric batteries." C. H. L. CLARKE. Dated August 18.

10581. "Galvanic battery." E. M. GARDNER. (Communicated by T. L. Kauffer.) Dated August 18.

10600. "Electric furnaces and heating apparatus." J. E. ROGERSON, J. G. STATTER, J. S. STEVENSON. Dated August 18.

10607. "Electro deposition of aluminium." W. R. LAKE. (Communicated by Count R. de Montgelas.) Dated August 18. (*Complete.*)

10074. "Applying and utilising ordinary water supply of dwelling houses, &c., for the generation of electricity. J. W. NEWMAN. Dated August 6.

CORRESPONDENCE.

The Upward Battery.

Referring to Mr. King's letter, reprinted from the *English Mechanic*, I wish to make the following observations. Having settled the theoretical side of my battery, I plainly foresaw that the whole future success of the apparatus lay in mechanical arrangement and detail, ease and absolute safety of manipulation, together with entire absence of skilled labour.

Certainly, the arrangements for generating, storing, and automatically supplying the gas are most important points, and absolutely necessary to give the cell itself a commercial value.

If Mr. King will allow me to say so, he has entirely overlooked the all-important function of the gas holder as his letter and experiments clearly show, hence the heavy leakage of gas. In practice, the measured charge of acid admitted to the retort is only sufficient barely to fill up to the last column of the gas holder, even if the gas is not being consumed by the battery, the latter being idle.

In order to convince Mr. King of the soundness and truth of the above, I shall be most happy to show him

the battery which has been in operation for the last six or eight months whenever he chooses to come to our works.

A. René Upward.

West Kensington,
August 18th, 1886.

I have read with attention a very interesting description in your columns of Mr. Upward's chlorine battery, in which the details of the apparatus are fully described.

Perhaps it may interest your readers if I give my experiences of this battery, which has now been working at my house for about eight months, in which it was fitted up at my request, as I wanted some form of electric installation, although I knew that it was then imperfect.

At first the installation gave considerable trouble, as it was not then out of the experimental stage. It has, however, been readjusted several times, and I can now say that it is working entirely satisfactorily.

With the new fittings there is not the slightest smell of chlorine—this I can answer for. The battery is also entirely free from leakage. So complete is the gas tightness that, when completely washed free of chlorine, it rises from 0 E.M.F. to 32 E.M.F. in about 10 minutes, and after being disused for 24 hours it only falls to about 30 volts. Owing to its constancy, it is impossible to overcharge the accumulators, and it seems to improve by use. This E.M.F. is on open circuit with 14 battery cells ; when joined up with 8 E.P.S. accumulators it falls to about 19·5 volts.

The porous cells, moreover, being impregnated with chloride of zinc, which is very deliquescent, never dry, even when the water is out of them, so that there is no crystallisation in them, and consequently no cracking. Owing to the absence of local action, the zinc plates, though unamalgamated, have wasted with exact uniformity, except in one cell, into which on examination I found that a piece of brass had fallen, this explaining the anomaly.

For experimental work in laboratories the battery is very useful, for of course with accumulators, induction coils and other apparatus cause risks of short circuiting, whereas here the primary battery may be used for running small dynamos, coils, &c., without fear of any damage being done, even if the whole circuit were short circuited for any time.

The automatic apparatus for sucking the gas through the cells is not often needed, as the chemical action usually gives sufficient suction ; but when needed it seems to act of itself in a very satisfactory way.

I have in my installation several small time saving accessories not mentioned in your paper, with these, it takes me five minutes to fill the cells up with water, turn on the gas, wash out the generator and charge it, after this it automatically charges up the accumulators without further attention ; when this is done, all that is needful is to turn the gas out and leave it. I think, however, that with advantage some appliances might be fitted to light the gas electrically, and automatically to extinguish it as soon as the accumulators begin to boil. All these sort of apparatus depend for their success on thorough good work and attention to detail, and I have now not the slightest hesitation in saying that if the details of this battery are properly fitted up with good work, the whole concern will be a success, and far the simplest form of generator for small installations.

Henry Cunynghame.

Hurlingham Lodge, Fulham,
August 17th, 1886.

[This letter, from a gentleman well known in the electrical world, will, we hope, set at rest the doubts which Mr. Sydney F. Walker and others have expressed respecting the practicability of the Upward battery. As for ourselves we are exceedingly pleased to find that it bears out the favourable opinions we formed when inspecting the apparatus.—EDS. ELEC. REV.]

I have been astonished to see that the dispute about this battery is not yet ended, as your last number contains several fresh communications about it, so it will not make much difference if, by your courtesy, I add one more to the number.

(1.) As regards the difficulty of finding out a leak in the pipes, I beg to suggest the following method, a clumsy one I admit, but still better than none at all. Let a rough trough or long box be made, put together with screws, and of a size that will just hold the battery comfortably, which can then be set up on the bottom piece, and the sides and ends put on afterwards, whenever required, by screws running into previously bored holes. If then at any time a leakage of the gas becomes perceptible let the trough be put together, and filled with water so as to just submerge the battery, when the rising bubbles will show where the leak is.

If I understand the battery rightly, judging from the diagrams, the tops of the open zinc cells rise above the level of the other sealed cells, and these last could therefore be covered with water without flooding the others, though, as the zinc cells are habitually filled up with water, even flooding would not matter much.

Chlorine is a soluble gas, dissolving in two-fifths of its own bulk of water, but I should think this solution would not be carried on so rapidly as to prevent the rising of any bubbles at all.

(2.) The flame of a candle or taper would give to a considerable extent the locality of a leak, for the flame of such when brought into contact with chlorine begins to burn dim with a reddish colour and considerable smoke, and this in proportion to the density of the gas, for it will keep alight even in pure chlorine, and thus by passing a taper round the battery, the appearance of the flame would indicate the nearness to the leak, as immediately around this the greatest quantity of the escaping gas would be.

(3.) A wet mixture of starch paste with iodide of potassium will show the presence of chlorine gas directly it comes in contact with the mixture by a blue colour, deepening according to the quantity of iodine in the compound and the intensity of the chlorine action, which depends on the presence of water. If, therefore, some slips of paper were prepared, having on their surface this mixture, with a very small proportion of iodine, they could, in the event of a leak, be slightly moistened by being pressed with a damp cloth, and then passed over the surface of the battery, when the deepening blue would show the approach to the leak. A rough test could be made in this way by a slip of paper dipped in writing ink which would be bleached yellow to a certain extent, but the blue test is the more sure, and if the searcher had delicate lungs and did not care to put up with breathing a little of the gas, a broad strip of paper (*e.g.*, newspaper) could be cut about the length and size of the top of the battery, sponged over with ink diluted with water, and laid on top, when the bleaching of some particular spot would show the locality of the leak, or a strip of coloured wall paper wetted, would do. A wet handkerchief, however, tied over the mouth and nose, will enable one to breathe in the presence of a considerable quantity of chlorine gas, which in its passage through the wet material is arrested by the water and becomes hydrochloric acid, while the gas itself, being heavy and always lying on the floor, is not so inconvenient as light gases dispersed through the whole of the room.

(4.) There has been a great deal said about the impracticability of keeping the tubes gas tight.

Surely when we have in all our dwellings gas pipes of very common thin metal and often of India rubber, put up in all directions and contortions, and often anyhow, as regards skill, by a very slightly experienced plumber's improver, but which yet hold the gas at a pressure quite equal to that in Mr. Upward's battery, and last for usually many years without repair, there ought to be no difficulty in making the tubing of the battery to do as much. I have before now fitted up a

system of tubes for conveying pure nitric and sulphuric acids, and was able to keep them perfectly tight and unaffected, though exposed to the action of two of the most corrosive chemicals known. Surely so far as corrosion is concerned there should be no difficulty, for as regards most non-metallic substances, at all events, the corrosive powers of chlorine are very slight, while strength to resist pressure is simply a matter of material and thickness and good workmanship in jointing.

(5.) As to the possibility of servants disarranging the battery by meddling with it, the same objection applies to all electrical apparatus, and can be met by the remedy generally in use, *i.e.*, not allowing the place where the battery is kept to be entered by any person save the one to whom the care of the battery is entrusted, and if this one cannot be trusted to do what he is told and no more, then the battery can be permanently locked up in the trough I have already described, which for this purpose would require a lid.

I have not, unfortunately, had an opportunity of examining one of these batteries, but the construction and working seem to be very simple as compared with the ordinary primary batteries, while one of Walker's electrometers placed in the circuit between the + pole of the battery and that of the accumulators would always tell, if such exact accuracy was desired, how many ampère hours there were in the latter, as the consumption each night could be pretty well judged, the number of lamps or burners in use in any average household being generally the same every night; as also is the time of burning, as a rule, but of the latter a note could be kept. The current taken by each lamp would be always the same, and the number in use multiplied by the hours they had been kept alight would always give the ampère hours taken out, while the electrometer would give by direct reading those put in. This calculation, however, simple as it is, would only be necessary in the event of a ball or party or some other unusual expenditure of light.

The battery seems to have one great point, viz., that to preserve it in efficiency, the principal thing is (as with accumulators) after it has been once set up and is working well to *let it alone*, but if it should get out of order, in these days of fast trains and cheap fares, it ought not to be a matter of any difficulty or much expense to get a man from the makers to put it right.

In reference to this question of getting out of order, I have been greatly surprised to see the bitter hostility with which Mr. Upward's invention seems to have been received by many of the electrical fraternity. If he had perfected an apparatus for enabling the public to do without electricity altogether, he could not have been much more roughly handled than he has been in some quarters, while it is manifest that these implacable critics could not have had an opportunity of putting the battery to an actual practical test, for it has not been before the public a sufficiently long time for that. Surely it would have been wiser, to say nothing kinder and more courteous, had these gentlemen instead of indulging in predictions of failure, waited, for say, six months, till a few sets of the battery had been tried for that time, and then reported the actual experience of it instead of condemning the whole affair in advance. Irrespective of the actual merits of his invention, any inventor who produces an apparatus designed to extend the application of electrical light and power by bringing them within the reach of householders to whom they were before forbidden by cost or circumstance, deserves rather thanks and help than hostility, especially from brother professionals. That is "the unkindest cut of all."

Edward Conry.

August 16th, 1886.

[Leaks could be discovered by much simpler means than that described by our correspondent, but, as a matter of fact, there will be no leaks to find. Mr. Conry's kindly sentiments will no doubt be appreciated by the inventor of the battery.—EDS. ELEC. REV

I had hoped not to have troubled you again upon the above, but as Mr. Crawley repeats his assertion that there is no H Cl formed in the carbon cell in the manner suggested, notwithstanding the fact that he has found some H Cl in the drainings from the said carbon cell. Perhaps you will allow me to ask him whether we are to understand that the water (H_2 O) which is present is not electrolysed; and if not, how he accounts for the fact, seeing that the E.M.F. present is sufficient to accomplish it. If he is of opinion that the water in the cell *is* decomposed, what becomes of the hydrogen gas? I would also ask him whether chemical analysis of the contents of the inner cell fail to show anything which arises from the oxidation of the zinc.

Sydney F. Walker.

August 19th, 1886.

The Hastings and St. Leonards-on-Sea Electric Light Company.

From your "Notes" in the ELECTRICAL REVIEW, August 13th, it would appear that the above company is wanting in signs of vitality as regards lighting.

It is also stated that "year after year has passed and no extension has been made in public lighting." This is no fault of the company, as an offer was made to the town authorities to extend lighting the front line, but was not accepted. Perhaps a few facts would be interesting as to our vitality. At the present we are supplying the electric light at no less a distance than 1½ miles from our central station by means of about seven miles of cable in underground pipes. The area of lighting includes 1,500 yards of sea front, the Hastings Pier, theatre, hotels, shops, and private dwellings, also the Robertson Street Congregational Church.

The enclosed cutting from a local newspaper (the *Hastings and St. Leonards Observer*) speaks for the quality of the light as supplied by us, and its use in photography.

Ed. W. J. Hennah, *Secretary.*

[We are pleased to record the fact that the company is doing such good work. Our remarks last week were, of course, based upon the discussion which took place at the Town Council meeting. The cutting relating to photography will be found alluded to in our Notes columns.—EDS. ELEC. REV.]

The Calibration of Voltmeters.

The article on the "Calibration of a Cardew Voltmeter," in your number of the 6th inst., stands perhaps in need of a little explanation. The sentence beginning "For the dependence," on page 133, seems hardly intelligible.

But, after all, the method is chiefly one of comparison with a torsion galvanometer, and the latter is not an independent instrument, seeing that it records the opposing forces of a permanent magnet and a spring, both of them subject to variation.

Methods are given partially in text books for the calibration of voltmeters by comparison with a known example of E.M.F., as, for instance, Dr. Fleming's form of the Daniell.

Generally, however, they appear to be written by professors of experience, who are unable to descend to elementary details, such as too often puzzle the amateur.

It would be of great interest if someone well qualified for the task would kindly explain *ab initio* how, with a standard cell of any known E.M.F., one or more galvanometers, a resistance box, or bridge, or both, and a variable supply of current (whether from dynamo or battery), the calibration of a voltmeter may be accomplished.

Ajax.

What is a Filament?

As this word appears to twisted and turned about into all shapes, perhaps it would be as well to define its true and real meaning. I find, on looking into Bailey's English Dictionary, published early in the year 1766, a well-known standard work at the time, that it defines the word "filament," which is described under three heads as follows, viz. :—

1. Medicina. 2. Anatomy. 3. Botany.

1. Filaments are described as little slender rays like threads which appear in the urine.

2. Are the small fibres or threads which compose the texture of the muscles.

3. Small threads which compose the beard of roots.

Now, Mr. Edison, although not the first to call a carbon conductor a filament, appears to me to have wrongly done so, and both he and Mr. Harrison have erred in calling their carbon conductors filaments, and as two wrongs will not make one right, neither should be entitled to claim the use of the above word, which has been wrongly imported into electrical science.

Now, if Mr. Edison had called his carbon conductors (which are said to be peelings of cane) *shreds*, instead of filaments, it would be a far more appropriate and correct term for the material used by him.

Mr. Edison has undoubtedly a very good lamp, and is clearly entitled to protection from infringement for his particular process of manufacturing carbon conductors, *but that is all;* and to my mind any lamp maker making lamps upon a different principle is clearly entitled to do so, even in the face of Mr. Justice Butt's decision which, to my mind, is wrong, and is certain to be reversed on appeal before a body of learned judges.

Surely, if Mr. Edison claims to use something wrongly defined, his patent in law must consequently be bad and therefore void, and in the face of facts the company is very premature in attempting to claim a monopoly for lamps until the definition of the word filament is upheld and recorded on the files of

"Filacer Filacium."

Telephonic Repeaters.

I have read with interest a letter of Mr. A. R. Bennett upon the above subject published in your issue of July 16th, 1886.

I think Mr. Bennett makes a mistake when he assumes that I *claim* "that the first use of induction coils wound with two circuits of approximately equal resistance for the purpose of connecting metallic circuits to ordinary single lines, was made in September, 1879, by Mr. Lockwood."

I don't "claim" anything. I only make a cold statement of an absolute fact in telephonic history.

I have read carefully over my paper which was published in your issue of July 9th, and also the item to which Mr. Bennett refers as being published in the pages of your British contemporary the *Electrician*, and fail to find anything which need excite his ire.

He says that I explicitly stated that no benefit was derived from the use of coils so made in the trial of 1879 ; I do not so understand my statement, nor was it so meant. I further stated that the well known use of the induction coil in the Blake transmitter would readily suggest the kindred use of coils in repeaters. This I still believe, and my belief is independent of the style of manufacture of the coil. The fact that telephonic pulsations occurring in a primary helix have the power to set up corresponding currents in a secondary helix of much higher resistance and length of wire ; and the converse but equally well-known fact, that such transmission could be reversed, and the high resistance secondary helix caused to repeat into the short primary helix, naturally led us over here to the conclusion that it would be a decided improvement to use fine wire for both coils, and to wind them together.

I don't think I ever admitted a failure ; and I do not consider that there is any discrepancy between my two statements, beyond what might be expected from two differing accounts of any transaction delivered with a lapse of three years between them.

Let me say here that I have no desire to dispute the originality of Mr. Bennett's device. I have not the slightest doubt that the idea came to him the same way it did to us, spontaneously and naturally ; but it is really no fault of mine that it was, as I have already stated, naturally suggested by the previous use in connection with transmitters.

Referring to Mr. Bennett's remarks concerning American electricians who went to Europe in 1881, none of whom knew anything about coil translaters, although some knew me ; and also that in 1883 he received a letter from Mr. Haskins, of the Wisconsin Telephone Company, saying "that attempts had been made in the States to use translating coils but without success, &c.," I can only say that the United States covers a good deal of ground, and that if Mr. Bennett ever comes over here, as I hope he will, he will find it quite possible to do many things in Massachusetts, that will be never heard of in Wisconsin. It may be also proper to state that the construction of lines long enough to necessitate translaters or repeaters, had barely commenced at the time of the exodus of American electricians ; so that their telephonic knowledge was, as a rule, limited to local or exchange work.

The operating telephone companies of the United States are all licensees for certain limited territory of the American Bell Telephone Company ; and even at this late day we who are in the service of the parent company perform many experiments and perfect many inventions that the licensed operative companies know nothing about.

The book I published in 1882 did not profess to give the latest information about telephones, as Mr. Bennett intimates, but was merely a compilation of fugitive sketches designed for the instruction of inspectors.

I am sorry to see that Mr. Bennett feels compelled to criticise my phrase about Mr. Watson "engineering the induction coil." Let me assure him that this unfortunate phrase was merely a specimen of my American-English, intended to go down easily into the minds of my hearers, and had no reference to any complicated system of operation. I had no idea that the REVIEW would honour me by a reproduction of my paper, or I would have been careful, and I should have said "Mr. Watson made the connections at the intermediate station."

En passant, I desire also to say that this Mr. Watson was the energetic and persevering co-labourer with Professor Bell in his telephonic researches ; and his being regarded as a supposititious character arose merely from the fact that when Mr. Bell was delivering his early lectures upon the telephone Mr. Watson was invariably at the distant end of the line, and, consequently, though constantly addressed by Mr. Bell, was never seen by the public.

In conclusion I desire to state that I am not one of those iconoclasts who whenever they hear of a novel and useful invention set themselves promptly to work to find anticipators therefor. I do not, for example, believe that because Bourseul had a dim vision of a speaking telephone in 1854, and described a Morse key and sounder operated by the human voice, he should be set up, as he is by Wm. C. Barney, as the inventor of the telephone ; or that because Mr. Reis materialised the same idea, and has subsequently, and since Bell gave the telephone to the world, been glorified by Professor Silvanus P. Thompson, he should be considered as the inventor of the telephone.

Therefore I desire not to depreciate Mr. Bennett's invention, but simply to show that *our* use of the repeating coil in the United States was not the outcome of that invention, but is the fruit of the researches of the electricians of the American Bell Telephone Company. It will be observed that in each case where I have had occasion to speak of our work of 1879 I have used the phrase "Mr. Watson and myself." This indicates that to Mr. Watson the chief credit is to be

ascribed, and such is the case; my share in it was quite subordinate.

Apologising for taking up so much of your valuable space, I remain

Thomas D. Lockwood.

Boston, U.S., *August 2nd*, 1886.

Remarkable Incandescent Lamp Patents.

As every little scrap of information in connection with the above subject is devoured and treasured by the users of incandescent lamps, perhaps it may interest some of your readers to learn a few facts respecting two particular inventions, one of which, to my mind, is very remarkable, claiming as it does a historical career, and is well worthy of the study of electrical engineers.

The lamp I allude to is the joint invention of Mr. W. E. Sawyer and Mr. Albon Man, who a few years back were residents of New York and Brooklyn, who in the year 1877 became somewhat aroused at the success obtained by Dr. Woodward, of Toronto (an Englishman by birth), to whom, it may be mentioned, the honour is due for having invented and introduced into Canada the first practical carbon glow lamp, which was exhibited by him in the year 1874 at a grand garden party held at Montreal, as recorded in the Canadian Press of that date.

Messrs. Sawyer and Man then began following in Woodward's footsteps, and studying the question of incandescent lighting, and attempted to improve the Woodward and other lamps then known in America, and, with the assistance of an expert agent, obtained letters patent for an incandescent lamp having thirty claims, which lamp was afterwards patented in England in the year 1878, and known in this country as Cheesbrough's patent, which invention since that date (whether legally or not remains to be proved) has undergone considerable changes, both financially and scientifically, which makes its history somewhat remarkable, especially as a correspondent in New York informs me that Cheesbrough, of Liverpool, duly assigned his interest in the patent in 1878 to an American by the name of Jacob Hayes for the sum of 5s., which is a clear proof it was not considered of much value at that date. Mr. Hayes, after going to the expense of keeping the patent afloat for about six years, got tired of his bargain and resold it, and went through the usual form before Mr. W. H. Broadnax, a United States Notary Public, in May, 1884, by assigning his interest to one James Yate Johnson, an Anglo-American gentleman, well-known in the Edison circles, for the large sum of one dollar, thus losing tenpence over the transaction, besides transfer fees, and the costs and expenses incurred by him during his ownership of the patent.

Next we find this invention, by some miraculous means, on its way back to England, and is then handled by Mr. Swan and Stearn, and afterwards transferred by the firm of Swan, Stearn and Johnson to the Swan Electric Light Company, and by them in due course to the Edison and Swan United Electric Light Company, Limited, the present owners thereof.

It would be a little interesting to learn how many profit and loss accounts have been opened in connection with this invention, also how much money has been expended in chopping and cutting up the original specification of the inventors, whose original claims of thirty in number have dwindled down to three.

Another most remarkable fact in connection with this invention is, it has crossed the Atlantic several times and has been a frequent visitor in the Law Courts of England and abroad; and, if reports are true, it may yet have to prove its validity, and the payment of the 5s. paid for parchment.

It may also be of interest to know that the services of Dr. Woodward have been secured by my firm, as an expert witness in our case pending against the Edison and Swan Company.

Dr. Woodward is possessed of a store of information in connection with the art of lamp making, and should there be occasion for him to give evidence on our behalf, we have no doubt that his information will bring out many interesting facts of great importance to those interested in the manufacture of incandescent lamps.

Arthur Shippey.

Arc Lamps.

In your last issue you gave a description of an arc lamp of German origin, the merit of which was stated to be its extreme simplicity. This idea, however, is by no means new, as your readers may find on reference to my English patent, May 28th, 1883, which fully describes and illustrates a magnetic brake controlling an iron disc exactly as shown in the Wenzel lamp. I would remark that Mr. Gulcher seems to me to have been the first to invent and use a magnetic brake, and he did this by direct application to the carbon holder rod, thus going a step further in the direction of simplicity.

Great simplicity in arc lamps is no doubt very desirable, and innumerable patents have been obtained for this end, but a long experience leads me to the conclusion that a really good and reliable series arc lamp requires more mechanism or electrical arrangements than shown in the Wenzel lamp.

James Brockie.

London, *August 17th*, 1886.

[Mr. Brockie's opinion on such a subject is, of course, of the highest possible value, for no one, we consider, is more qualified to judge the merits of an arc lamp.—EDS. ELEC. REV.]

Mr. Dierman's Cell.

With regard to the lead plate in the above cell giving the same E.M.F. as a carbon one, Mr. Dierman will remember how very careful Mr. Upward was to avoid anything like positive assertion in his letter about this and all other points in this cell. On the contrary, he was careful to explain that his objections were simply those which would have occurred to anyone on theoretical grounds when reading Mr. Dierman's description.

Since that gentleman has actually tested this particular combination, and, as I understand him, finds the E.M.F. identical with that of a cell with a carbon plate, we feel it would be discourteous not to accept the statement until we have time to thoroughly investigate the matter for ourselves. Assuming the fact, Mr. Dierman's explanation is, I think, the only one possible.

When I last referred to the matter, having no experimental proof either way, I left the question open, and merely noted that Mr. Dierman held to his statement as I understood it. I did not positively affirm anything whatever—such a course would, without experimental proof, have been most unscientific. Mr. Dierman says he finds no difficulty due to the formation of lead chloride. There is but little time now even for necessary experiments, so I must again content myself with noting the statement till it can be investigated. I venture to think, however, that he will in time find very great difficulty not only from the chloride directly, but also from the consequent disintegration of the lead plates. I hardly think also that he will obtain a good permanent seal. I hope Mr. Dierman will be able to let us have a few facts and figures on the subject when he describes his cell.

I may add that I saw Mr. Upward's remark about H O before it was sent in, and quite agreed with it. Whatever may be the practice of some French electricians in keeping up an old habit, English scientific men are too consistent to retain old formulæ dependent on a theory which has been dead and buried for the last 20 years at least.

C. W. S. Crawley.